

# Bothalia

A RECORD OF  
CONTRIBUTIONS  
FROM THE  
NATIONAL HERBARIUM  
UNION OF SOUTH AFRICA  
PRETORIA



EDITED BY  
**R. A. DYER, M.Sc., D.Sc., F.R.S.S.Af.,**  
CHIEF, DIVISION OF BOTANY, DEPARTMENT OF AGRICULTURE, PRETORIA AND  
DIRECTOR OF THE BOTANICAL SURVEY OF THE UNION OF SOUTH AFRICA

---

THE GOVERNMENT PRINTER PRETORIA  
1954



## CONTENTS.

---

	PAGE
1. MICROMORPHOLOGY OF LOWER HYMENOMYCETES. <u>P. H. B. TALBOT</u> .....	249
2. A NOTE ON STERIGMATA IN GENERAL. M. A. DONK.....	301
3. THE GENUS STEREUM IN SOUTH AFRICA. <u>P. H. B. TALBOT</u> .....	303
4. ON THE GENUS LOPHARIA KALCHBRENNER AND MACOWAN. <u>P. H. B. TALBOT</u> .....	339
5. SOME GRAMINICOLOUS SPECIES OF HELMINTHOSPORIUM AND CURVULARIA OCUR- RING IN SOUTH AFRICA. K. M. PUTTERILL.....	347
6. CONCERNING SOME SOUTH AFRICAN PESTALOTIOPSIS STEYAERT (PESTALOTIA AUCT. NON DE NOT.) R. L. STEYAERT.....	379
7. THE MORPHOLOGY AND ANATOMY OF UTRICULARIA TRANSRUGOSA STAPP. J. SLINGER.....	385
8. THE NOMENCLATURE OF SPECIES OF ALLOPHYLUS IN SOUTH AFRICA. B. DE WINTER.....	407
9. THE NOMENCLATURE OF THE CAPE ACACIA. I. C. VERDOORN.....	409
10. NEWLY DESCRIBED SPECIES (VARIOUS AUTHORS).....	415







# Micromorphology of the lower Hymenomycetes.

By

P. H. B. Talbot.

To classify the lower Hymenomycetes, not often distinguished by their shape, colour or hymenial configuration, mycologists eventually turned to the microscope to seek more exact diagnostic characters. As far as the circumscription and identification of species is concerned, microscopy has revealed many useful characters. But the other ideal of taxonomy, namely a natural classification, is still far from realisation as the significance of facts already observed has only partially been evaluated.

This paper is an attempt to review with illustrations the morphology of the microscopic organs found in the lower Hymenomycetes, special attention being given to the basidium. For amplification examples are cited from other groups of fungi as well. Some standard of terminology has been aimed at, particularly with regard to the basidium. The conclusions reached are that Linder's terminology for the basidium is unacceptable as it over-simplifies this organ, while Neuhoff's terminology is based on homologies which are unacceptable. Moreover, Neuhoff's terminology is flexible and in many instances would vary according to the subclass in which a particular fungus is classified. We believe, with Donk, that the place or stage of karyogamy, and the place or stage of meiosis, are fundamentals which should be used in formulating a terminology for basidia.

The new term **protosterigma** coined by Dr. M. A. Donk, is published here for the first time with its originator's generous permission. The term is explained in a note on sterigmata in general provided by Dr. Donk, which should be read in conjunction with this paper.

## Morphology, Cytology and Terminology of Basidia.

(NOTE.—In reading this section, reference should be made to Fig. 1 for terminology and to Fig. 2 for cytology).

In the simpler Hymenomycetes, basidial characters are most important for the recognition of genera and higher ranks, and studies of basidial types have led to a better understanding of basic relationships on which to build a more natural classification (Juel, 1898; Maire, 1902; Neuhoff, 1924; Gäumann, 1928; Donk, 1931; Rogers, 1934; Martin, 1938; Linder, 1940; Heim, 1948, 1949). Rogers (1944) summarised the position in stating that classification is implicitly an embodiment of an hypothesis concerning phyletic relation and that arising from this there are two views of reliable indications of relationship in the Hymenomycetes, viz. (1) that hymenial configuration is a reliable indication of kinship and (2) that the basidium and associated characters are reliable indications of kinship, and that hymenial variations are comparatively recent and trivial. There seems no doubt that the second view is the more acceptable one. Increasing use of the microscope has demonstrated affinities which were long unsuspected.

One of the most significant steps in the study of Basidiomycetes was the recognition of the homo- and heterobasidial subclasses by Patouillard (1900), and the resultant attention given to basidial morphology. Since then, many new facts have been observed about the morphology and cytology of the various types of basidia, but there is still much controversy in their interpretation, and particularly in the terminology applied to the different parts of basidia.

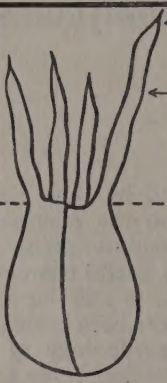
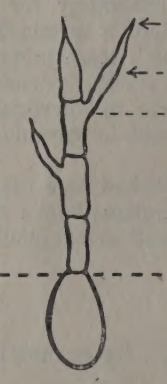
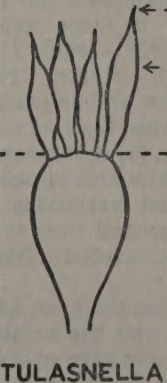
	LINDER	NEUHOFF & ROGERS	DONK
 TREMELLA	STERIGMA	STERIGMA	SPICULUM
	STERIGMA	EPIBASIDIUM	PROTO-STERIGMA } STERIGMA
 SEPTOBASIDIUM	BASIDIUM	HYPOBASIDIUM (4-CELLED)	METABASIDIUM ( REPLACING PROBASIDIUM )
	PROBASIDIUM	PROBASIDIUM REPLACED BY HYPOBASIDIUM	PROBASIDIUM
 TULASNELLA	STERIGMA	STERIGMA	SPICULUM
	STERIGMA	EPIBASIDIUM	PROTO-STERIGMA } STERIGMA
	BASIDIUM	HYPOBASIDIUM	METABASIDIUM ( REPLACING PROBASIDIUM ) •

FIG. 1.—Three mature heterobasidial types, *Tremella*, *Septobasidium* and *Tulasnella*, drawn diagrammatically to indicate the terminologies used by Linder, Neuhoﬀ (as elaborated by Rogers), and Donk.



In any science terminology is necessary to define objects unambiguously. For objects such as basidia, which are composed of a number of different parts, it is necessary that only those parts which are entirely homologous (and not merely similar, or analagous) should receive the same name. By homologous is meant "fundamentally corresponding in value or relationship with one another". For such structures to be homologous they must develop in the same way, serve the same function, have the same relation to a fundamental type, or have the same relative position (Shorter Oxford

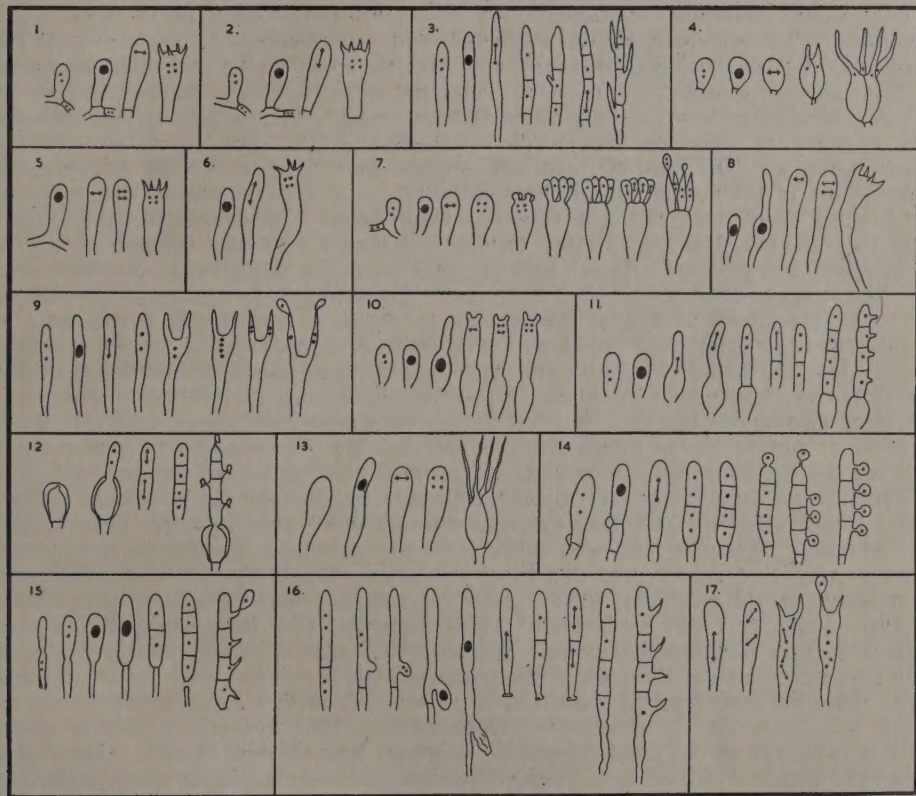


FIG. 2.—Diagrammatic representation of cytological changes in several types of homo- and hetero-basidia. Details reconstructed from information or illustrations by authors cited below:—

1. Karyogamy followed by chiasitic meiosis. 2. Karyogamy followed by stichic meiosis. 3. *Auricularia* (Maire, 1902). 4. *Sebacina* (Whelden, 1935 b). 5. Agaricaceae, *Hygrophorus* (Maire, 1902). 6. *Cantharellus* (Maire, 1902). 7. *Tulasnella* (Rogers, 1932). 8. *Vuilleminia* (Maire, 1902). 9. *Guepinia* (*Dacryopinax spathularia*) (Bodman, 1938). 10. *Brachybasidium* (Gäumann, 1922 a). 11. *Jola* (Gäumann, 1922 b). 12. Uredinales (Linder, 1940). 13. *Hyaloria* (Martin, 1937). 14. *Phleogena* (Shear & Dodge, 1925). 15. *Mycogloea* (Olive, 1950). 16. *Helicogloea* (Baker, 1936). 17. *Clavaria* (Maire, 1902). Note that there may be minor variations in different species of the genera cited, but that the course of events has been generalised. Note too that the spindle orientation is variable in some species, and also the plane of septation.



English Dictionary, 1933). Terminologies have been proposed or clarified by three recent exponents of various hypotheses, namely Neuhoﬀ (1924) and his followers, especially Rogers (1934) and Martin (1938), secondly Donk (1931) and thirdly Linder (1940). These terminologies are illustrated diagrammatically in Fig. 1. Of these, Rogers's contribution has perhaps received the most support; but the time has come to re-examine all three in an attempt at reevaluation and clarification.

In the older descriptions of Basidiomycetes there was little differentiation in terminology of the various parts of the basidia. The whole organ was known (as it is now) as the basidium. Sterigmata and probasidia were recognised as parts of the basidium. The term probasidium originated with van Tieghem (1893) to denote the basal vesicles of the basidia of rusts and smuts, i.e. the teleutospores and chlamydospores of these groups respectively; but it was later rightly extended by Donk to include all primary basidial cells in the same stage of development, and particularly the more or less resistant or persistent vesicles in a similar position on the basidia of the Auriculariaceae. The term sterigma was applied to such spore-bearing structures as those found in the normal clavate homobasidium, as well as to tubular extensions of the primary basidial cell found in Heterobasidiomycetes. One cannot accept Boedijn's (1937) contention that the primary basidial cell and its tubular extensions (e.g. in *Helicogloea*) are separate organs; they are each part of a single organ, the basidium.

The first consideration is whether an extended terminology is essential or whether we may be content, as Linder (1940) was, to return to the simple terminology of probasidium, sterigma, and basidium. The bone of Linder's thesis is phylogenetic, namely that the septate basidium and germination of the basidiospores by repetition are primitive characters. To quote, "The basidium, once established, is essentially the same throughout the class, but has undergone simplification as a result of loss of septation. Also it has in higher forms taken over the functions of the probasidium and become the locus of both caryogamy and meiosis. Because of the essential unity in structure and function of this organ, the relevant terminology can be greatly reduced and a return made to the simple descriptive terms which were in vogue previously".

Although phylogeny has been called "the playground of imaginative theorists", there is a phyletic implication in all plant classification. It is likely that the simplification or reduction in the basidium, which Linder suggests, has been the course of evolution of these fungi, and not as Neuhoﬀ (1924) suggested that heterobasidial types are derivative from homobasidial types. Martin (1938) agrees that the clavate basidium with four sterigmata at the apex of the gonotocont is a reduced, and not a primitive, type. He also observes that reduction is carried still further in the Gasteromycetes, whose sterigmata may be eliminated. Rogers (1934, 1947) comments at some length on this reduction in the Gasteromycetes, in whose homobasidia there is degenerative variability with loss of function. Their sterigmata, no longer serving as spore-projectors, are either grotesquely long and tenuous, or progressively short and obsolescent.

Let us now examine Linder's simple terminology and see how adequate it is in homologising and defining the different parts of heterobasidia (See also Figs. 1 and 2).

(1) PROBASIDIUM.—The term used by van Tieghem (1893) in the connotation given above, was extended by Donk (1931) to include all basidia in the stage between the formation of the primary basidial cell until the time that it forms protuberant extensions which bear the spores directly or indirectly. This is undoubtedly "that part or stage in which karyogamy occurs" (Donk, 1931). Such a definition homologises such diverse structures as: the basal sac of *Helicogloea*; the young, undivided cell of *Tremella*, which later becomes four-celled; the persistent or resistant basal vesicles of some Auriculariaceae, e.g. *Septobasidium*; the young basidium of the Dacryomycetaceae before forking; and the young, clavate basidium of the higher Hymenomycetes before production of sterigmata. Whether these cells are narrow or inflated, thickwalled and resistant or thinwalled and evanescent, does not alter the basic fact of their homology. The point is that these cells bear the same relation to one another in time of appearance



in cytological function for karyogamy, and in development to give rise to further structures designed for spore formation and liberation. Variations such as sclerotic walls are surely insignificant except as biological or ecological adaptations.

For Linder (1940) to limit the term probasidium to the precursor of the young basidium in rusts, smuts and Auriculariaceae is to ignore the potentialities of essentially the same type of cell in other Basidiomycetes.

In some basidia (see Fig. 2) both karyogamy and later meiosis take place in the primary basidial cell which we have here termed the probasidium. In others, karyogamy and meiosis are separated in place, as well as in time of occurrence. Rogers (1934) expresses the view, concerning ancestral types, that if both these events took place in the primary cell (hypobasidium), four nuclei were available to thrust out the four extensions of the wall which he terms epibasidia (e.g. in basidial types such as *Tremella* and *Tulasnella*). On the other hand, if meiosis were delayed and took place in an extension of the hypobasidium, there was only one nucleus to thrust at the wall, and thus only one extension (epibasidium) would be formed (e.g. in basidial types such as *Helicogloea* and other Auriculariaceae). Although it has been shown by Whelden (1935 a, p. 52) and also by Bodman (1938) that the epibasidia of some heterobasidiomycetes may sometimes be initiated before meiosis of the fusion nucleus, Rogers' explanation given above would certainly appear to be a good one connecting morphological and cytological development in heterobasidia, at least in ancestral types. But can this be used, as by Rogers, to homologise the epibasidium of *Tremella* with that of *Auricularia*? If so, can it ignore the fact that the sterigmata of the clavate homobasidium are produced in the same way as the epibasidia of *Tremella*, yet receive a different name? We think it cannot. On the above explanation Rogers (1934) states that there are two fundamental phyletic tendencies among Basidiomycetes (a) those which have epibasidial meiosis and (b) those with hypobasidial meiosis; but he adds that Donk's distinction between the part or stage of karyogamy (probasidium) and the part or stage in which meiosis occurs (metabasidium) introduces a false complexity. If, however, the phyletic tendencies and the morphological differentiation depend upon the place of meiosis, is this not a fundamental character which should be used in formulating a terminology?

To put the argument another way: Baker (1936) has stated, "If karyogamy and meiosis both take place in the hypobasidium, several epibasidia result; if meiosis is delayed and takes place in an extension of the hypobasidium there can be only one epibasidium". Again we do not question the correctness of this statement, but only its interpretation for the purposes of a terminology. All that is implicit in this statement forms the crux of the differences between the terminology of Neuhoﬀ and followers, and Donk. From Rogers' and Baker's statements above, the conclusion must inevitably be that the form of the mature basidium is conditioned by the time and place of meiosis, and not that the time and place of meiosis are conditioned by the form of the mature basidium. Yet Rogers accepts the second alternative by basing his terminology on the morphology of the mature basidium, and rejects Donk's terminology which is based on developmental morphology arising from cytological change.

Now, is it possible to homologise the epibasidia of the *Tremella* and *Auricularia* types? Emphatically no! Taking in order the criteria of homology as defined previously, we shall see how the two views clash, and which view best meets the case.

(A) *To be homologous the structures must develop in the same way.*

The epibasidia of *Tremella* and *Auricularia* both develop supposedly in response to the thrust of nuclei and protoplasm upon the wall of the young basidial cell in which karyogamy has occurred; but in *Tremella* the nucleus first divides so that there are four daughter nuclei available to thrust out four extensions. In *Auricularia* the whole protoplast and its single nucleus thrusts out a single extension and the nucleus then



divides. In *Tremella* the epibasidia bear spores directly upon their narrowed apices. In *Auricularia* the epibasidium divides into four cells, and in each cell a nucleus is present to thrust out from the epibasidial segments, terminal or lateral extensions on whose narrowed apices the spores are borne. The development of the epibasidia is certainly not the same in both cases.

(B) *To be homologous the structures must serve the same function.*

The epibasidia of *Tremella* merely serve to carry the nuclei to the spores, and if necessary they may extend so that the spores are produced in the open. The epibasidium of *Auricularia* serves as the place of meiosis, then from its cells are produced the extensions which are necessary for nuclear migration to the spores. These extensions are capable of elongation to meet the ecological need; not so the epibasidium itself which remains fairly constant in length. Surely it is the extensions which are homologous with the epibasidia of *Tremella*. It is naturally realised that extension of part or the whole of the basidium is only one aspect of the variability of heterobasidiomycetes. For example, in *Vuilleminia* it is the metabasidia which extend to enable the spores to be produced at the surface. Taken alone, the functional aspect of extending epibasidia is perhaps not important in homologising these structures, but in conjunction with other facts, particularly morphological, it seems to have a bearing on the subject.

(C) *The structures must have the same relation to a fundamental type.*

Here there is a phyletic implication, which may be largely speculative in fungi, but nevertheless cannot be ignored as it is the basis of our ideas on classification. We therefore agree with Rogers that Basidiomycetes show two distinct phyletic tendencies (a) those with epibasidial meiosis and (b) those with hypobasidial meiosis. This only serves to strengthen the argument that on account of the different places of meiosis in *Tremella* and *Auricularia* their epibasidia cannot be homologised.

(D) *The structures must have the same relative position.*

In *Tremella* and *Auricularia*, the structures which are called epibasidia are both borne as extensions of the cell in which karyogamy takes place. However, the sterigmata of clavate homobasidia are formed as extensions of a cell in which karyogamy takes place in exactly the same way as in *Tremella* by upthrust of four daughter nuclei. On this view the sterigmata must be homologues of the *Tremella* epibasidia, which Rogers does not accept. In *Auricularia* although the epibasidium is borne as an extension of the cell in which karyogamy takes place, it is not another homologue because meiosis has not yet occurred. It is the terminal or lateral extensions of the epibasidial segments in *Auricularia* which have the same relative position as the epibasidia of *Tremella* and the sterigmata of higher Basidiomycetes.

Neuhoff's terminology does not stand the tests of homology, which have been defined here in most inclusive terms.

(2) BASIDIUM.—Linder (1940) defines a basidium as "that organ which is in part the homologue of the ascus, and which following karyogamy and meiosis bears the basidiospores either directly or through the interpolation of the sterigmata".

It must be accepted, as previously stated, that the *whole* organ including any basal vesicle or cell, any septate or non-septate extensions, and any spicules on which the basidiospores are borne, must be included in the term basidium. This inclusive sense of the term may be what Linder intended, but actually his definitions limit the term to the part of the basidium left after subtracting probasidia and sterigmata. If this interpretation is correct, then obviously Linder's simplification does not suffice. For descriptive taxonomy alone it would cause unwarranted circumlocution and confusion. The whole mature organ must be called the basidium, and other names sought for its parts. It appears difficult to settle upon terms which convey these distinctions satisfactorily. Neuhoff's epibasidium implies the same as Linder that the spore-bearing



tubules are something "upon the basidium" and not a part of the basidium itself—though this interpretation is not qualified by its application. Donk's term metabasidium may be translated as something which is "the conclusion of the basidium", although the metabasidium is also only part of the whole basidium. The original meaning of the term probasidium was "that which comes before the basidium", but now as an antithesis to metabasidium it may be interpreted as "the first stage of the basidium".

(3) STERIGMATA.—Linder (1940) applies this term to "that structure which arises from the basidium and bears the basidiospores." He continues, "The restriction of the sterigmata to apply only to that portion of the spore-bearing filament which is very slender and through which the nucleus squeezes in its passage to the spore, not only leads to confusion but is illogical."

It has been put forward that there are two criteria of a true sterigma:—

- (a) Neuhoff (1924) gives the cytological criterion that the nucleus in passing through a true sterigma to a spore, becomes elongated and assumes the staining properties of chromosome-material. All Neuhoff's followers have accepted this as the criterion of a sterigma. Quite obviously the nucleus must elongate to squeeze through a narrow passage, but it has been argued that the spatial relation is inconsequential because in many species the nucleus has been observed to elongate and change its staining properties before it actually reaches the narrow passage. This is taken to indicate that the area approaching the passage is distinguished in some way other than narrowness from the remainder of the tubular appendage, and should be named differently. Early attenuation of the nucleus was observed in *Helicogloea* (Baker, 1936), *Exidia* (Whelden, 1935 a) and *Tremella* (Whelden, 1934), and may be accepted as fact. If, as in *Helicogloea*, elongation of the nucleus is initiated in the epibasidial segments well before the nucleus approaches the narrow passage, or if elongation occurs at a variable distance from the passage, what are to be regarded as the morphological limits of the "true sterigma"? Where is the point where one may say, "Here the epibasidium ends, and here the sterigma begins?" There are a few exceptions, e.g. *Xenolachne* (Rogers, 1947) where there is a fairly sharp distinction on account of the grossly attenuated, long sterigma, and also in *Tulasnella tulasnei* (Rogers, 1932, pp. 95–96) where the sterigmata elongate greatly as an adaptation to the presence of a gelatinous matrix round the basidia. Even in these it is possible that the nucleus might elongate at a variable distance from the morphological "sterigma". It is obviously impossible to set the limits of the "true sterigma" without a cytological investigation of each and every basidium in development, and even then it may be found that this point is variable in a single species, or even in different basidia of the same specimen. Further, may not the change in staining reaction be due simply to the physical fact of elongation, so that the nuclear components are spread out and of necessity become coloured differently from an opaque and compact body? Such an effect is frequently seen in staining blood smears, where the staining reaction of the nuclei of various types of cells depends to an extent upon the thinness of the smear.
- (b) Buller's (1922, p. 31) criterion of a sterigma is functional and not cytological, viz. that a sterigma is an organ for bearing and forcibly discharging the spore. True, forcible discharge is not universal. There are gymnocarpous Basidiomycetes in which forcible discharge is either impossible or of no advantage to the fungus, and in these the sterigmata have lost their function, becoming reduced to very short attachments or alternatively becoming disproportionately long and filamentous. In either of these instances the attachment of the spore is delicate and enhances the possibility of its being set free by fracture. In other words this reduction or distortion is an adaptation to loss of function,

and must strengthen the opinion that the functional criterion of a sterigma is important. Rogers (1947) has given a clear account of such basidia, terming them apobasidia with the definition of an apobasidium as "a basidium whose basidiospores are not apiculate, nor borne obliquely on the sterigmata, nor forcibly discharged".

Further to the functional aspect, it has been argued that the epibasidium is an adaptation to ensure that the migrating nucleus shall be transported through varying depths of jelly in gelatinous Heterobasidiomycetes to the surface, where a true sterigma may be formed in the open to serve its function of discharging the spore freely and with the greatest possible chance of subsequent dispersal. We do not question that this process occurs, but only that it serves further to distinguish the parts called epibasidia and sterigmata by Neuhoﬀ. Considering the whole organ as designed to bear and liberate the spores under the best possible conditions, why, from the fact that part of it is capable of elongation to meet the environmental conditions, should that part be held a separate entity? And further, it is true that in some instances [e.g. in *Tulasnella tulasnei* (Rogers, 1932)] the other part, namely the narrow terminal pedicel or "true sterigma" of Neuhoﬀ, is also capable of extension when embedded in a gelatinous matrix. Baker's work (1936) on *Helicogloea* shows that if the epibasidia are immersed each cell may develop a tubular extension as an adaptation to the immersed condition, but protruding epibasidia form "sterigmata" directly without the need for tubular extensions. In this case, are the lateral extensions and the sterigmata to be held apart, or are they merely variations of a single organ? Surely the second alternative! Again, in *Vuilleminia* the whole basidium may elongate according to the depth at which it is embedded in a semi-gelatinous matrix. Variation in length to meet the environmental conditions is certainly not solely an attribute of epibasidia. It occurs in epibasidia, and in sterigmata (both sensu Neuhoﬀ) and also in metabasidia (sensu Donk). Variation, as Rogers (1934) justly observes, is one of the hall-marks of Heterobasidiomycetes, and is largely a response to the ecological conditions and especially to the water factor. One comes to the conclusion that the whole tubular appendage is a single entity in which the nucleus migrates to the apex, elongates on approaching, but at no fixed distance from the narrow passage with change in staining properties, and enters the spore which is finally discharged. Conditional upon the type of basidium and the depth at which it is embedded, the basal part or sometimes the narrower apical part of the spore-bearing organ, or even the whole basidium, may elongate to ensure that the spore is formed and receives its nucleus in the air, so that it may be freely liberated for dispersal.

From the foregoing we can agree with Donk (1931) and Linder (1940) to call the whole tubular spore-bearing appendage a sterigma. But there is still the somewhat exceptional case of *Tulasnella* to consider. In the development of the *Tulasnella* basidium there are two divergences from the usual state in most heterobasidia, namely that the "epibasidia" are cut off by basal septa, and that the first post-meiotic mitosis takes place in the "epibasidia".

The ovoid form of the *Tulasnella* epibasidium is suggestive of a spore; this fact has led to its being considered as a sessile basidiospore which germinates in place to form a conidium. Heim (1949) has suggested that the basidia of *Tulasnella* are similar to teratological basidia of certain Homobasidiomycetes, in which the basidium produces a prolongation terminating in a sporoid body, the latter liable in turn to produce a conidium. Heim terms this prolongation (epibasidium sensu Neuhoﬀ) a hemibasidiospore, and its terminal "spore" a basidioconidium, which can produce secondary conidia. He suggests that the whole structure composed of hemibasidiospore and basidioconidium, corresponds to a sessile basidiospore produced incompletely by an

accelerated sporogenetic rhythm. This is essentially a more modern version of Juel's (1897) interpretation of the *Tulasnella* basidium as one bearing sessile basidiospores germinating in place to give secondary spores or conidia. Rogers (1932) summarised Juel's points for this interpretation and provided convincing counter-arguments to show that Juel's points are, on the whole, not antagonistic to Neuhoﬀ's conception of this basidium. Donk (1931, p. 115) has also dismissed Juel's interpretation mainly on the grounds of similarity in the basidia of *Tulasnella* and *Botryobasidium* (*Pellicularia*). This would perhaps be more correct if the similarities offered were as between *Tulasnella* and *Ceratobasidium* (some species of which were formerly placed in *Botryobasidium*).

In *Tulasnella* (Rogers, 1932) following karyogamy and two meiotic divisions of the fusion nucleus, the epibasidia are formed and are then cut off by a basal septum from the rest of the basidium. In the epibasidia there follows the first post-meiotic mitosis, after which one of the daughter nuclei migrates to the apical sporoid body. Rogers (1932, p. 100) states, "Mitosis within the appendage is not the impossible behaviour of an extension of the basidium that it would be for a sterigma." This statement should at least be qualified by the definition accepted for a sterigma, for both epibasidia (*sensu* Rogers) and sterigmata (in our sense) are extensions of the basidial cell. Certainly the "sterigma" of Rogers (*i.e.* Donk's spiculum) would be too confined a space in which to expect mitosis. But is it correct to say that this mitosis within the tubular organ really distinguishes this organ from homology with similar organs which apparently only serve for migration of the nucleus and spore-bearing? If it is held that they are not homologous solely on this account, then equally well these tubes cannot all be called epibasidia, nor sterigmata. On the other hand, if they are homologous then they may be called either sterigmata or epibasidia according to choice of terminology. Taken alone, the first post-meiotic mitosis within the tubes of *Tulasnella* cannot serve as an argument for not calling these organs sterigmata.

Martin (1938) observes that the place of meiosis should not be regarded as a fundamental basidial character as it may take place within the limits of the original cell (pro- or hypobasidium) or within extensions of the cell wall (epibasidium). He considers it a secondary character, conditioned at least in some instances by the nature of the zeugite. If we took up this premise then it would be illogical to regard either Donk's probasidium (the place of karyogamy) or his metabasidium (the place of meiosis) as fundamental. But we have already observed that the two fundamental phyletic tendencies in Basidiomycetes are indicated by epibasidial meiosis and hypobasidial meiosis, and that the morphological differentiation of the basidium is connected with the place or stage of meiosis. That being so, this is most surely a fundamental basidial character, which governs the final form of the basidium. The possibility that meiosis may take place in one of two set places and thus be bound up with the production of either one or several extensions of the primary basidial wall, points to this feature as fundamental. But on the contrary the place of the first post-meiotic mitosis cannot be considered fundamental, for it does not alter the established pattern of morphological change. In Hymenomycetes it may occur either in the metabasidium, or in the sterigmata (our sense) or in the spores, and is not bound to a fixed site. In *Tulasnella* (Rogers, 1932, p. 103) all three possibilities seem to occur. In the basidia with more than four sterigmata the first post-meiotic division is likely to occur in the metabasidium; in some species it is known to occur in the sterigmata; and in a few other species it is unknown either in the metabasidium or in the sterigmata, hence likely in the spores. But note that in all these instances the general pattern of the *Tulasnella* basidium is unchanged. In several other genera the first post-meiotic mitosis occurs in the spores (*cfr.* Maire, 1902). As this mitosis may occur in the metabasidia or in the spores, there is no reason why it should not be expected in an intermediate organ, the sterigma, especially if the last passes through an accumulative phase in which it achieves a certain degree of independence from the rest of the basidium, and if it is spacious enough to permit nuclear division to occur.



In the Clavulinaceae (Gäumann, 1928, p. 532) the mature basidia contain eight nuclei as a result of a triple division of the diploid nucleus, the number of sterigmata is variable, the spores each contain one nucleus, and a variable number of nuclei degenerate within the body of the basidium. The position regarding the third division of the fusion nucleus within the basidium is much the same in the Cantharellaceae (Gäumann, 1928, pp. 533–534). Also in a species of *Kordyana* (Gäumann, 1928, p. 530) the basidia may be the seat of extra (abnormal for the species) divisions under certain weather conditions, producing extra nuclei for which extra sterigmata are formed.

The foregoing arguments, it is hoped, serve to show that the occurrence of the first post-meiotic mitosis within the spore-bearing organ is not a valid argument for not calling this organ a sterigma in *Tulasnella*. Now, what about the basal septation of these organs in *Tulasnella*? There seems no *a priori* reason why a sterigma on receiving its protoplast and nucleus, should not become inflated and separated from its parent cell by a septum, particularly if this represents an accumulative phase in which the nucleus is about to divide. The fact is, however, that apart from *Tulasnella* and certain irregular cases recorded in *Ceratobasidium* and in some Dacryomycetaceae (Rogers, 1934, p. 170; Rogers, 1935, p. 4), septa are not known at the base of the sterigmata. It is part of the Neuhoff school of thought that epibasidia may be characterised by production of septa; it is not commonly a way of characterising a sterigma, although it could be argued that just as a spore may become septate, so also could a sterigma without justifying a change of name. The standpoint we adhere to is that this is merely another aspect of the variability of heterobasidia particularly in a primitive type coming near to its Ascomycete ancestors.

There is a good deal of agreement between many workers (cfr. Rogers, 1932, 1934; Gäumann, 1928; Heim, 1949) that the spore-bearing organ of *Tulasnella*-type may have originated from a type of Ascomycete showing ascospores thrusting out the wall of the ascus and germinating exogenously by a conidium. On this hypothesis Rogers (1934, p. 168) suggests that "the *Tulasnella* basidium, as highly organised as any existing type, is phylogenetically closest of existent types to the antecedent ascus", and further that the epibasidia are essentially homologous with ascospores. The same explanation may be given for the origin of the sterigma, and is accepted as that here; or it may also be given as the origin of the sporoid hemibasidiospore of Heim's interpretation. Allowing now for the primitive nature of the *Tulasnella* type of basidium, or of its immediate ancestors in which the process of exogenous spore formation may be only lightly established, what is more likely than that there should be variations in this process? And what variation is more likely than one involving the degree of independence of the ascospore (or the derivative "epibasidium") from its parent cell, i.e. the formation of septa?

The close affinity of *Ceratobasidium* (Rogers, 1935, p. 4; Martin, 1948, p. 114) with *Tulasnella* makes possible either the derivation of the former from the latter type of basidium, with loss of septation, or suggests an independent derivation of *Ceratobasidium* from an Ascomycete type, in this case no septa appearing at the base of the sterigmata. The fact that there are occasionally adventitious septa in *Ceratobasidium* (Rogers, 1935) is highly suggestive that this process was once a normal occurrence in a related type which has now been lost. Alternatively it may argue the derivation of the *Tulasnella* type of basidium from that of *Ceratobasidium*. Whichever way about, it shows that the septation is variable as would be expected in a primitive type. From types such as *Ceratobasidium sterigmaticum*, with two inflated sterigmata, (Rogers, 1935, 7, fig. 4) could be derived the Dacryomycete basidium which is known to produce occasional adventitious septa (Rogers, 1934, p. 170) in the sterigmata, while *Pellicularia flavesceus* with inflated cornute sterigmata and repetitive spores (Rogers, 1935; Rogers, 1943, p. 105) provides a link between *Ceratobasidium* and other *Pellicularia* species and hence to the Corticiaceae. From the inflated and septate sterigma to the filamentous and non-septate sterigma there are a series of known types which

indicate the possible phylogenetic changes, and simultaneously there has been a change from variability in these features to stability. In essentials the sterigma has remained the same throughout, an organ for the migration of the nucleus to the spore and one which bears and discharges the spore.

If the sterigmata are called epibasidia in *Tulasnella* and *Ceratobasidium*, but sterigmata in *Pellicularia* (which includes species such as *P. flavescens* with sterigmata no different from the *Ceratobasidium* epibasidia) one is bound to establish a special family Ceratobasidiaceae (Martin, 1948, p. 114). If all these structures are sterigmata, and they undoubtedly are all homologous, such families are at least suspect.

From the foregoing we accept the tubular sporebearing structure(s) *in toto* as a sterigma. Donk has differentiated the apex of the sterigma by the term spiculum (coined by Tulasne, 1853) and the lower part of the sterigma by the term protosterigma (coined by Donk, and used here for the first time in publication with his kind permission). This differentiation in the terminology of the parts of the sterigma is best understood by referring to Dr. Donk's own "Note on Sterigmata in General". (See p. 301).

This interpretation of the sterigma may not be accepted by followers of Neuhoff's terminology. But again consider the case of an auricularious basidium like that figured for *Septobasidium* in Figs. 1 and 3. Here the part which we call a sterigma is entirely homologous with the same extensions in a *Tremella* basidium. To us they are both sterigmata. To Neuhoff those structures in *Tremella* are four one-celled epibasidia (or "not separate cells, but extensions of the hypobasidial segments"—Martin, 1938). But in the auricularious basidium, organs having the same morphology, function and cytology are either known as sterigmata (if they are short consequent upon being produced on emergent basidia) or as unnamed lateral extensions of each cell of the four-celled epibasidium (if they are elongated consequent upon being formed on deeply immersed basidia). In the latter instance Donk has ironically suggested (in Litt.) that it would be logical to call them epiepibasidia! It cannot be controverted that the Neuhoff School homologises the four epibasidia (sterigmata in our view) of *Tremella*, with the single four-celled epibasidium and its lateral extensions or sterigmata of the auricularious basidium. The point is that the sterigmata, in our sense, of the auricularious basidium are regarded as part or extensions of the epibasidium by Neuhoff, but as the whole epibasidium in tremellaceous basidia. To equate the part (in *Tremella*) with the whole (in *Auricularia*) is preposterous, and on this contention alone it is impossible to accept Neuhoff's terms epi- and hypo-basidium.

On the other hand, the four-celled parts of the *Auricularia* and *Tremella* basidia are entirely homologous and should receive the same name. Both develop from a probasidium in which karyogamy occurs. In both meiosis takes place, followed by septation (differing only in the plane of septation) and production of a sterigmatic outgrowth from each cell. That the plane of septation is different is of little importance, as is shown by the fact that in various Tremellaceae marked variation in the plane of septation may occur (Whelden, 1935 c).

Now, having rejected Neuhoff's and Linder's terminologies can we accept Donk's? We have already accepted his probasidium, and sterigma composed of protosterigma and spiculum; there remains to consider his metabasidium, for whose acceptance some arguments have already been given. The definition of a metabasidium as that part or stage of the basidium in which meiosis occurs, is a cytological one. It may be held that a definition based on cytology is impracticable in routine work on morphology and taxonomy, and thus an undesirable, even though fundamentally true, definition. It may be held that Neuhoff's terms are simpler to apply, that the swollen basal part of the basidium is the hypo-basidium and that everything above that is the epibasidium, except the spore-bearing spicules, which are true sterigmata. In practice Donk's terminology is no more difficult to apply: a probasidium, whether as a resistant or merely as a primary basidial cell can be recognised at once; so can the sterigmata or



tubular spore-bearing filaments; what is left is the metabasidium, which in some cases quite obviously replaces the primary cell.

Now consider the basidia of *Phleogena faginea* (Shear & Dodge, 1925) and *Mycogloea carnosa* (Olive, 1950), both illustrated in Fig. 3. In *Phleogena* there is a basidial stipe bearing a cell in which successively karyogamy, meiosis, transverse septation and production of lateral spore-bearing filaments occur. In Neuhoﬀ's terminology, the whole basidium here must be an epibasidium, but this epibasidium is not a structure seated "upon a basidium" or even upon a hypobasidium. It is instead simply seated upon a basidial stipe, i.e. a basidium-bearing hypha. Donk's terminology, however, accounts for a probasidium replaced by a (four-celled) metabasidium each cell of which bears a sterigma and spore. It appears to the writer that the developmental connotation in Donk's terminology is important, and that it is insufficient to define a basidium only on its mature morphology.

Or again, in *Mycogloea*, there is a basidial stipe bearing a cell which is similarly changed from a probasidium to a metabasidium with sterigmata. Again Neuhoﬀ's terminology is quite inadequate as it allows only for the epibasidium.

Further interesting basidial types, which put terminology to the test of constancy to the same principles, are those in which the basidia are somewhat intermediate between other well-known basidial types such as characterise different families or even sub-classes. Their intermediate nature allows actual or potential disagreement on their taxonomic position. Is the terminology applied to one and the same part of the basidium to change according to the family or sub-class in which the fungus is classified? A good example is *Patouillardina* (*Atractobasidium*), illustrated in Fig. 3, 10. The author of this genus did not describe it adequately or quite correctly (Bresadola, 1906 and 1920, p. 52), but appeared to place it in the Auriculariaceae. Martin (1935, 1939, 1945) has classified it in the Tremellaceae on account of the "regular perpendicular alignment of the second basidial septa with reference to the first septum", but also noted that the basidia are somewhat intermediate between those of these two families. Thus Martin would consider that the basidium is composed of one four-celled hypobasidium, each cell bearing an epibasidium. Suppose now a good reason were found for allying *Patouillardina* with the Auriculariaceae; the basidium would still be exactly the same but the terminology would be reversed. The basidium would then be composed of a four-celled epibasidium, each cell of which bears an extension. In Donk's terminology, no matter which classification is accepted, the names of the parts of the basidium remain constant, i.e. in *Patouillardina* there is a probasidium which develops into a four-celled metabasidium, each cell bearing a sterigma.

Another example is *Peniophora heterobasidioides* (Rogers, 1935, p. 30-31). This has affinities with both homo- and heterobasidiomycetes, but is classified as homobasidial with sterigmata and repetitive spores. If the sterigmata had been a little more swollen, can we not suppose that they would have been called epibasidia and the fungus classed as a heterobasidiomycete?

The genus *Ceratobasidium* is placed as a heterobasidiomycete with a primitive type of holobasidium (Rogers, 1935, p. 4; cfr. Martin, 1948). This assignation is probably correct, as indicated by the germination of the basidiospores by repetition. But suppose the point were controversial and it could be held that these were homobasidia. If they are heterobasidia, Rogers' terminology provides for a hypobasidium surmounted by a number of stout epibasidia. If they were homobasidial, the same basidia would be said to consist of basidia with four sterigmata. Donk's terminology for both homo- and heterobasidia of this type is inflexible. For him the basidia of *Ceratobasidium* consist of a metabasidium and four sterigmata, no matter which sub-class is to receive the genus.



Similar arguments apply also to the basidia of *Pellicularia* (*Botryobasidium*), which has already been touched on. Rogers (1935, 1943) classes some species of *Pellicularia* (e.g. *P. flavescens*) as homobasidial, with sterigmate basidia; yet these species have stout, cornute sterigmata no different from those of *Ceratobasidium*, which Rogers classes as heterobasidial, with hypo- and epibasidia. *Ceratobasidium* also links with *Tulasnella* through such species as *C. anceps* in which the epibasidia are not cut off by a basal septum.

### To what Extent are Morphology and Cytology linked?

From the examples given above in various connections it is obvious that the probable sites of karyogamy and meiosis can be inferred from the mature morphology of the basidium, given the basic knowledge we already have of the cytology of a number of basidial types. The place of the first post-meiotic mitosis, variations in the plane of formation of the septa, and the plane of the mitotic spindles cannot generally be inferred. One might suppose that generally in a broad ovate or clavate basidium there would be sufficient space for the mitotic spindle to lie horizontally (i.e. chiasitic division). This does not always happen, for in such basidia stichic division, with the spindle placed longitudinally, sometimes takes place. Also in a narrow, cylindrical basidium the spindle might be supposed to lie longitudinally, but again this is not constant. The orientation of the spindle is not even to be correlated with the class of the basidium, for stichic and chiasitic types may occur in either homo- or heterobasidiomycetes. Examples of such variations in spindle orientation may be seen by reference to Fig. 2.

The plane of the spindle may not even be constant in a single species (e.g. in *Helicogloea lagerheimi*, Baker, 1936; *Sebacina globospora*, Whelden, 1935 c). It is not impossible that this might be due to sectioning technique, but it might just as well be due to natural variation. Despite this, there is probably not one species sufficiently investigated in this regard that cannot be definitely classed as either chiasitic or stichic, especially if in deciding this character one restricts oneself to the first division, which has the longest spindle, and neglects the following ones. In many cases cytology helps to underline differences in basidial shape which would otherwise be underrated or even overlooked, or are difficult to express in terms of basidial morphology (cfr. *Clavulina*, stichic and *Clavaria*, chiasitic). However, where the character of spindle orientation has been used as a primary basidial character (Juel, 1898; Maire, 1902; Gäumann, 1928) it has resulted in a quite unnatural grouping of genera. Its use in such instances has been properly censured by Rogers (1934) and Lohwag (1937). Its best use is as a secondary character for the separation of small groups, and certainly not as a primary one for the linking of large groups.

### Size and Shape of Basidia.

In the higher Hymenomycetes the hymenium is compact and resists lateral expansion of the basidia, with the result that they tend to be clavate or cylindrical. In simpler forms, which are often gelatinous or composed of loosely arranged tissues with an irregular or discontinuous hymenium, the basidia can expand laterally and assume many different shapes. Several of these types are illustrated in Fig. 3, which exemplifies the strange shapes encountered particularly among heterobasidia. A more complete collection of illustrations is not possible here, owing to the difficulty of obtaining suitable material for drawing, or in obtaining permission to reproduce published illustrations.

Basidia may arise singly at the apices of subhymenial hyphae, or in botryose clusters which are perhaps best seen in the genus *Pellicularia*. Basidia ranging in size from  $3 \times 7 \mu$  (*Corticium galzini*) to  $25 \times 210 \mu$  (*Aleurodiscus amorphus*) have been noted by the writer. To see basidia clearly, crush preparations of very thin sections mounted in 5 per cent potassium hydroxide solution to which a very small drop of 1 per cent aqueous phloxine has been added (Martin, 1934) have been found very satisfactory.

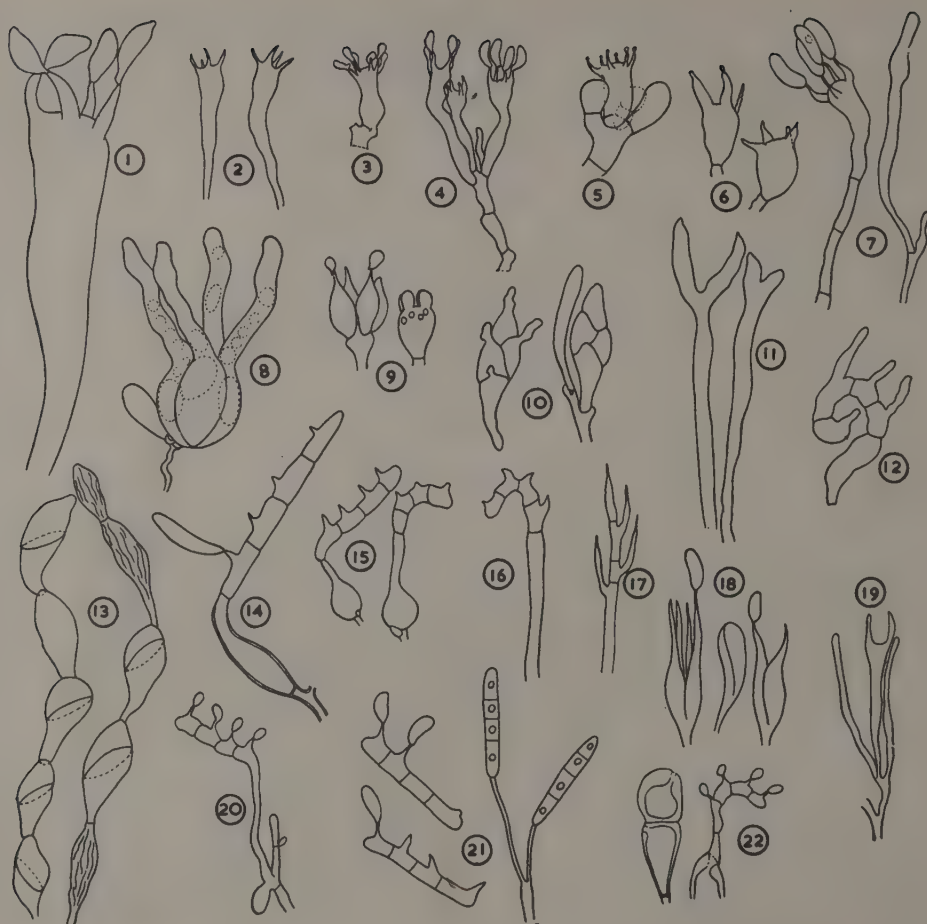


FIG. 3.—A selection of basidial types:—

1. *Aleurodiscus* sp. 2. *Craterellus sinuosus*. 3. *Trechispora raduloides* (after Rogers, 1944). 4. *Galzinia cymosa* (after Rogers, 1944). 5. *Botryobasidium coronatum* (= *Pellicularia pruinata*; after Rogers, 1934). 6. *Ceratobasidium fibrillosum* (after Martin, 1948). 7. *Vuilleminia comedens*. 8. *Sebacina megaspora* (after Martin, 1936). 9. *Tulasnella violacea* (after Rogers, 1934). 10. *Patouillardina cinerea* (after Martin, 1935, as *Attractobasidium corticioides*). 11. *Femsjonina luteoalba*. 12. *Neotyphula guianensis* (after Martin, 1948). 13. *Sirobasidium brefeldianum* (after Coker, 1920). 14. *Septobasidium burtii* (after Couch, 1938). 15. *Cystobasidium sebaceum* (after Martin, 1939). 16. *Helicobasidium purpureum*. 17. *Auricularia* sp. 18. *Eichleriella* (the two figs. to the right after Bourdot & Galzin, 1928; the one to the left, *E. incarnata*, after Bresadola, 1903). 19. *Dacryomyces deliquescens*. 20. *Helicogloea lagerheimi* (= *Saccoblastia sebacea*; after Wakefield & Pearson, 1923). 21. *Mycogloea carnosa* (after Olive, 1950). 22. *Puccinia caricis* (after Grove, 1913).

### Summary of Terminology for Basidia Accepted here.

*Basidium*.—That organ of the Basidiomycetes which is partly the homologue of the ascus, and which following karyogamy and meiosis bears the basidiospores either directly or on extensions of the gonotocont wall, the sterigmata. The term is taken to include the probasidia, metabasidia and sterigmata as parts of the whole basidium.

*Probasidium*.—That part or stage of the basidium in which karyogamy occurs, i.e. the primary basidial cell. Included also in this term are the teleutospores of Rusts, the chlamydospores of Smuts, and the more or less persistent or resistant cells in the same stage of development in the Auriculariaceae. The term is intended to denote the "first stage of the basidium" rather than "that which precedes the basidium".

*Metabasidium*.—That part or stage of the basidium in which meiosis of the diploid nucleus occurs. In many basidia it obviously replaces the probasidium. The term is intended to denote the final stage of the basidium as an antithesis to the first stage, or probasidium.

*Sterigma*.—That part of the basidium which comes between the metabasidium and the basidiospores, or the elongations of the metabasidium through which the nuclei migrate to the spores which are borne terminally. The sterigma is composed of a basal, filamentous or inflated part called the protosterigma, and an apical point called the spiculum on which the spore is borne. (See also pp. 301-302).

*Holobasidium*.—An unseptate basidium. It is most common in homobasidiomycetes, but is sometimes encountered among heterobasidiomycetes, e.g. in *Ceratobasidium* and *Dacryomycetaceae*.

*Phragmobasidium*.—A basidium which is divided by septa. The metabasidium is divided into a number of cells (usually four) by cruciate or parallel septa after meiosis, or in some instances the sterigmata are separated from the metabasidium by basal septa. The term is the antithesis of a holobasidium.

*Heterobasidium*.—A basidium of the Heterobasidiomycetes.

*Homobasidium*.—A basidium of the Homobasidiomycetes.

*Heterobasidiomycete*.—A basidiomycete in which there is a phragmobasidium, or if the basidia are holobasidia then the sterigmata are differentiated as stout, subulate or cornute structures associated with basidiospores which germinate by repetition. The definition of a Heterobasidiomycete based on the presence of an epibasidium is inherently unsound because, as we hope to have shown, the epibasidium itself is not defined in such a way as to represent a constant entity. Among holobasidia such as found in *Dacryomyces* or *Ceratobasidium* the "epibasidium" is recognised in practice as a swollen, stout sterigma associated with other characters such as spore repetition, or elongation of the sterigma to meet the environmental conditions, which give the clue to the heterobasidiomyceteous nature of the fungus. The concept of an epibasidium is quite unnecessary for the definition of a *Dacryomycete* basidium.

*Homobasidiomycete*.—A Basidiomycete other than a Heterobasidiomycete. The group is characterised by basidia which are not septate, do not possess stout, swollen sterigmata, and which produce basidiospores which germinate directly to form a mycelium.

### Texture.

Although the character of texture is a complex of several properties, and eludes precise definition, it has sometimes been used successfully in the taxonomy of the resupinate Hymenomycetes, for example by Bourdot & Galzin (1928) in the genera *Corticium* and *Peniophora*. Texture is a physical character, but may be modified by chemical changes. This occurs in matrices which become gelatinous, mucilaginous



or ceraceous, or which have mineral matter deposited in the tissues. In the higher Hymenomycetes, especially those which are coriaceous, suberose or ligneous, the consistency of the pileus and cuticle may be correlated with the type of hyphae and their direction in a particular plane (Ames, 1913, p. 220; Lohwag, 1940). In resupinate Hymenomycetes the texture depends mostly on the compactness of the hymenium in relation to that of the intermediate and basal layers, but it is also influenced by the thickness, and particularly the moistness of the fungus.

The texture may vary with the age of the fungus, and also with the relative rates of tangential and radial growth. Thus the margin of a fungus often differs in texture from the older parts, owing to a difference in compactness of growth. *Duportella tristicula* when young, is velutinate owing to the presence at the surface of numerous upright hyphae; later the hymenium forms above these hyphae and the fungus becomes membranous or coriaceous, with a rather waxy hymenium. Similarly, purely superficial modifications of texture may occur in the genera *Peniophora* and *Hymenochaete* by late production of cystidia and setae respectively. These often impart a glitter to the surface, and feel scabrid if they are sufficiently robust.

The texture may be modified by chemical change. *Ceraceous* fungi appear waxy. The tissues are usually compacted by a waxy substance which may obliterate the hyphae or render them indistinct, giving the impression of degeneration. The wax often forms an obstructive emulsion in alkaline mounts of sections. Gloeocystidia filled with oily globules can also give the fungus a ceraceous appearance. This state, where the waxy or oily substance is intracellular, contrasts with the commoner one where it invests the outside of the cells. The latter condition is particularly common in the genera *Acia* and *Phlebia*, but is by no means confined to those genera.

The hyphae of *gelatinous* species (Fig. 4, 1) often appear filamentous, only the lumen showing distinctly with stains like phloxine. Gelatinised hyphae are best stained with iodine or with ammoniacal aqueous methylene blue (Nannfeldt, 1947, p. 332), which reveals that the hyphae are frequently loosely intertexted but held together by a gelatinous substance. This has the power of imbibing water, in contrast with non-gelatinous matrices which absorb water by capillarity (Buller, 1922, p. 157). The gelatinous modification is characteristic of the majority of common Heterobasidiomycetes, where it would seem to be an ecological adaptation for securing quick imbibition and retention of water. It may also be regarded as the author of the heterobasidium, which requires a spacious hymenium for its development.

*Mucilaginous* species have much the same construction as gelatinous ones, but differ in having a matrix of thinner, slimy consistency.

A *corneous* texture usually results from the loss of water from tissues which were previously ceraceous, gelatinous or mucilaginous. This is exemplified in the genera *Tremella* and *Auricularia*, and in such species as *Peniophora gigantea*.

For taxonomic work on the lower Hymenomycetes, the types of texture described below are important:—

- (1) *Membranous* (Fig. 4, 5).—The hymenium is a compact palisade but not otherwise sharply differentiated from the subhymenial and deeper tissues, which are usually also fairly compact. The fructification may be adnate, separable, or held to the substratum by superficial intrusive hyphae. This group contains most of the species with thick, moist hymenophores.
- (2) *Pellicular* (Fig. 4, 4).—The hymenium is sharply differentiated as a thin crust lying above loosely arranged inferior tissues. The hymenium is continuous and compact at maturity, but at times may be discontinuous in patches thus appearing minutely poroid under the lens. Pellicular species are generally rather thin and

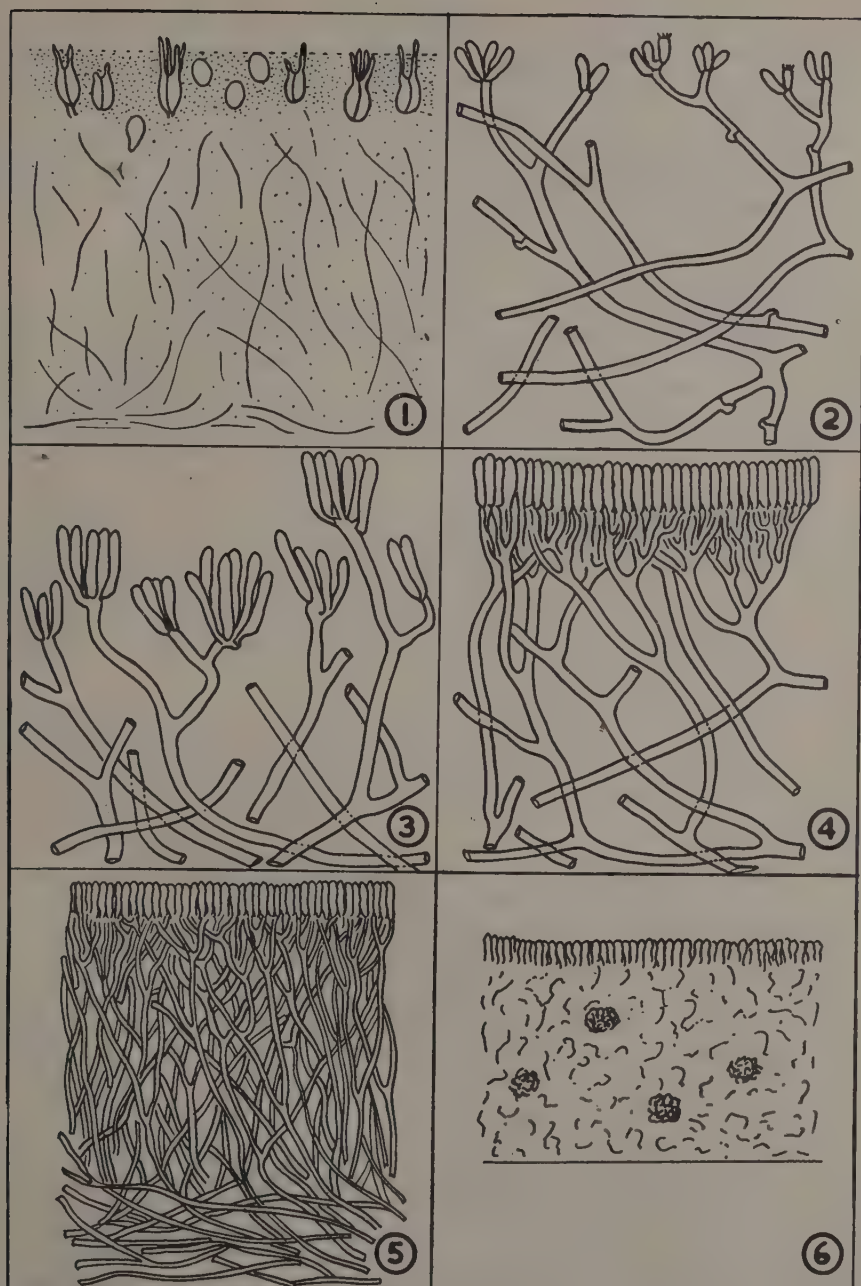


FIG. 4.—Diagrams of sections of fructifications of resupinate Hymenomycetes illustrating the arrangement of tissues in the following textural types:—

1. Gelatinous. 2. Arachnoid. 3. Byssoid. 4. Pellicular. 5. Membranous.
6. Crustose.

dry; the open nature of the tissues is doubtless responsible for quick drying out. The hyphae are usually very distinct. Most of these species are separable from the substratum by snapping of the basal tissues under tension.

- (3) *Byssoid* or *Floccose* (Fig. 4, 3).—Here there are no compact tissues, even the hymenium being irregular, discontinuous, and often staged at different levels. A fairly thick, tufted or woolly structure results, in which the hyphae are loosely arranged throughout. The hyphae are easily detached from the substratum by breaking under tension.
- (4) *Arachnoid* (Fig. 4, 2).—This type of texture is common in the young stages of growth but may persist into maturity, and then the hymenial elements are quite scattered and discontinuous. The hyphae are usually delicate (though not in the genus *Pellicularia*), and more or less adpressed to the substratum in an openwork structure reminiscent of cobwebs. When the elements of the fungus are so dry and discontinuous as to appear scurfy or mealy, then the terms *furfuraceous* or *farinaceous* are applicable; in a finer and more powdery state the structure may be termed *pruinose* or *pulverulent*.
- (5) *Crustose* or *Arid* (Fig. 4, 6).—Certain resupinate fungi are thin, dry, and compact throughout their tissues, and lack a distinct cortex. They are conveniently termed crustose. Usually they are adnate; frequently they are charged with mineral matter (e.g. *Aleurodiscus acerinus*). But it is more common for fungi to be *arescent*, that is becoming crustose only on drying, a character well shown in the section *Coloratae* (Bourdot & Galzin, 1928) of the genus *Peniophora*.

The successful use of texture as a taxonomic character is much limited by the difficulty in defining the types of texture unambiguously. With this in mind, Table 1 has been prepared so that the usage adopted by the writer may be checked by direct reference to material of several species differing in texture.

### Margin.

The type of margin depends typically on the compactness of the hyphae composing it, and the direction in which they are intertwined. It may readily be observed that as a resupinate fructification grows, new hyphae and young hymenial elements are differentiated behind the radially expanding periphery. Radial growth generally precedes the tangential growth which is responsible for knitting the hyphae together into a firm fructification. It is thus probable that the presence or absence of marginal hyphal strands depends largely upon the relative rates of radial and tangential growth. The marginal character is fairly constant, and useful in taxonomy. The more important types of margin (illustrated in Fig. 5) are fibrillose, fimbriate, arachnoid (byssoid), villose or pubescent, farinaceous, and pruinose.

Hyphae may be aggregated into thick mycelial strands which sometimes meander over the surface of the fructification or extend beyond the margin [e.g. the cords of hyphae found in *Coniophora arida*, and especially in the section *Radicatae* (Bourdot & Galzin, 1928) of the genus *Peniophora*]. Certain of the lower Hymenomycetes also develop rhizomorphs (e.g. *Asterostroma rhizomorpha*, *Septobasidium bagliettoanum*, *Helicobasidium compactum*). Absence of suitable material has precluded a study of these, but it would be interesting to know how far these thick mycelial cords approach the degree of differentiation of tissues seen in the rhizomorphs of some Agaricaceae [e.g. *Armillaria mellea*, where conducting vessels and hyphae are enclosed in a protective sclerotic rind; *Marasmius* species which form the rhizomorphs known as "horse-hair blights" (Petch, 1915)].



TABLE 1.

SOME SPECIES OF FUNGI WITH THEIR CHARACTERISTIC TEXTURE (MARKED O).  
THE PRINCIPAL TEXTURE MAY BE MODIFIED BY CHEMICAL OR PHYSICAL CHANGE  
TO OTHER TEXTURES (MARKED X).

[illegible]

### Sclerotia.

Sclerotia are stromatic aggregations of hyphae, sometimes as big as a mustard seed, with a compact rind and a mass of pseudoparenchyma within. They occur especially among some of the parasitic species of lower Hymenomycetes, which are pellicular or pruinose and liable to dry out, e.g. *Pellicularia filamentosa* (Rogers, 1943) and *Ceratobasidium anceps* (sub *Corticium*, Gregor, 1932). Probably owing to their hard rinds these sclerotia are able to withstand dry conditions. When present they are an aid to specific diagnosis, but they are not invariably found in any one species.

### Relation of hyphae to the substratum.

In his studies of the Thelephoraceae, Burt (1925, 1926) stressed the character of separability of the fungus from the substratum. The writer has examined the reasons why some fungi adhere firmly to the substratum, while others are easily separable. The property of adherence is not entirely an attribute of the fungus, but also derives from the nature of the substratum, and is thus not constant for the same species of fungus. The conclusion is that this character should not be stressed in taxonomy, though it is very interesting biologically. The following are some of the reasons for this conclusion:—

- (1) Species which are usually separable, may be adnate or separable in small pieces only, when growing on rough bark into the interstices of which the hyphae may penetrate and there form a compact mass.
- (2) Separation may be achieved either by snapping of the basal hyphae under tension, or by carrying away small pieces of the substratum. The character is thus dependent on the relative tensile strengths of the hyphae and the substratum, and in turn upon the state of decomposition of the substratum.
- (3) To some extent separability depends upon the composition of the basal tissues of a fungus, which will disrupt more easily if they are loosely interwoven even though such hyphae may be attached to the substratum by numerous intrusive hyphae spread over their entire under surface. There are indeed few resupinate fungi (e.g. *Aleurodiscus amorphus* and *A. disciformis*) which radiate from their primordium without putting down an extensive system of intrusive hyphae into the substratum.

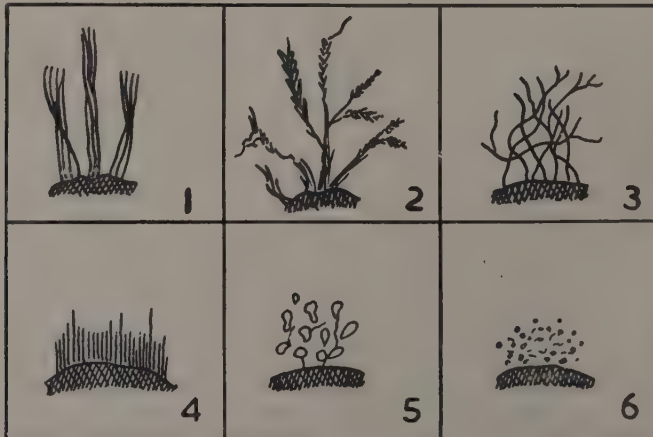


FIG. 5.—Diagrams illustrating terms used in describing margins of lower Hymenomycetes:—

1. Fibrillose. 2. Fimbriate. 3. Arachnoid or Byssoid. 4. Villose or pubescent. 5. Farinaceous. 6. Pruinoso.



The question of separability is closely linked with the way in which a resupinate fungus develops from its primordium. One may imagine a fallen twig becoming infected by a fungus. The sequence of events after infection must frequently be as follows:—

The hyphae first ramify through the subcortical layers of the twig then emerge through cracks or lenticels to produce hymenophores. This is supported by the observation that the wood is frequently permeated by hyphae, and that the primordia of the fructifications develop usually above lenticels or cracks in a hard substratum, such situations being paths of little resistance to emergent hyphae. That these hyphae are emergent is deduced from the simultaneous appearance of several primordia which later coalesce (e.g. in *Peniophora cinerea*, *P. quercina*, *P. aurantiaca*); for it is improbable, knowing the low germination rate of basidiospores in nature (Buller, 1909), that the tufts of mycelium at these foci are each the product of separate spores which have lodged in lenticels or cracks, achieved simultaneous germination, and sent down hyphae into the substratum. In some other species, e.g. the *Aleurodiscus* spp. mentioned above, there is often only one primordium and consequently only one deep-seated mass of hyphae concerned in the nutrition of the hymenophore. Sectioning of many fructifications which appear to have arisen from only one primordium and then spread radially, will often reveal that the hyphae lying behind the growing edge may penetrate into the body of the substratum. This effect of secondary penetration by the hyphae is sometimes concerned in giving rise to the adnate condition of resupinate fungi. From a biological point of view, the adnate condition may be supposed to confer an advantage on the fungus by assuring a supply of nutrients and moisture from a wider area of the substratum, and by protecting the fungus from easy dislodgment.

### New concepts in studying micromorphology.

Corner (1947, 1948a) has broken new ground in the study of micromorphology of the Basidiomycetes by introducing mathematical expressions derived from careful measurements of a great number of basidiospores, basidia and cystidia. These expressions appear to be of general application. They relate the length and width of these organs, and the volume and spore number of the basidia and basidiospores.

The ratio  $D/d$  (where  $D$  is the length, and  $d$  the width of the basidiospore) expresses the shape of the spore. This ratio plotted against  $D$  gives a locus which is called a "sporograph". Corner shows that a locus, and not a point determined by the average range of  $D$  and  $d$ , is necessary in studying the size and shape of basidiospores, i.e. that a developmental analysis is necessary to understand the adult structure. For example, in certain *Clavaria* species the sporograph clearly relates  $5.5 \mu$ , subglobose spores with  $10-17 \mu$  cylindric-fusiform spores. It shows that "giant spores" may not be freaks, but in certain species are spores of the same kind as normal ones only produced on basidia of greater volume than usual. It shows that spores of different kinds may have the same size and shape under certain circumstances. It also shows that in some species at least, micro- and macro-spores are inherently different kinds of spores.

Corner also derived the more general expression  $D = d(a + bD)$ , where  $a$  and  $b$  are constants for the species. The values for  $a$  and  $b$  define different loci for different kinds of spores. A similar relationship holds for basidia, viz.  $l = w(a + bl)$ , where  $l$  is the length of the basidium,  $w$  is its width, and  $a$  and  $b$  are constants for the species. This curve is termed a "basidiograph". The same expression holds for certain types of cystidia which were studied, and Corner proved that some types of cystidia were sterile, precocious and overgrown basidia.

Further studies (Corner, 1948a) on the basidium show that it may be regarded as a self-charged ampoule, containing dense protoplasm which is injected into the basidiospores by enlargement of a basal vacuole acting as a plunger. He established



FIG. 6.—A selection of basidiospores:—

1. *Corticium galzini*. 2. *Corticium microsporium*. 3. *Peniophora byssoidea*.  
 4. *Poria viridans*. 5. *Peniophora subalutacea*. 6. *Cytidia flocculenta*. 7. *Corticium tulasnelloideum*. 8. *Corticium lacteum*. 9. *Corticium niveocreum*. 10. Cor-



the mathematical expression  $V - A = nv$ , where  $V$  is the volume of the basidium,  $A$  is the volume of the initial vacuole,  $v$  is the volume of the spore, and  $n$  is the spore number.

Mathematical expressions such as these are essential for an analysis of the development of these organs, and may be used very successfully to determine whether certain morphologically dissimilar organs are actually homologous. This new concept in the study of micromorphology has been applied with striking success by Corner to a few carefully studied species.

### Basidiospores.

The basidiospores are borne singly at the apex of each sterigma, or they are rarely sessile in some Gasteromycetes. There are usually two to four sterigmata per basidium, but some species have a corona of 6–8 or more, which is particularly characteristic of the *Urnigera* section (Bourdot & Galzin, 1928) of the genus *Corticium*, that is the genus *Trechispora* Karst emend. Rogers (Rogers, 1944).

A selection of basidiospores is illustrated in Fig. 6. In shape they may be subglobose, ovate, oblong, cylindrical, elliptical, navicular, reniform, allantoid, cordate or pyramidal. They frequently have one side depressed and their shape may be modified by an apiculus. They may be hyaline or coloured a light brown, yellowish-brown, sepia, or less commonly brightly coloured in a mass, such colours usually being rosy, violaceous or blue-green. Often the spores are guttulate. Chlamydospores may be developed in the basidiospores of *Jaapia argillacea* (Fig. 7, 4). These are lightly coloured, and form in such a way that the ends of the basidiospore are distinct and colourless, thus this structure has sometimes been regarded as a guttulate basidiospore. Rogers (1935, pp. 29–30) disposes of that interpretation effectively. The majority of spores are smoothwalled, but in some species they are minutely sculptured, or in others bear large spines, warts or reticulations. Sculpturing is frequently accompanied by a slight thickening of the spore wall and also by coloration. Taken alone, sculpturing and coloration are not good generic characters, though they have often been misused as such. Miss Wakefield (1935) cites several examples of this misuse.

The range of spore size is large. To quote the two examples used in connection with basidia, *Corticium galzini* has spores measuring  $1.5\text{--}2.5 \times 3\text{--}4.5 \mu$ , while those of *Aleurodiscus amorphus* measure about  $22.5 \times 29.5 \mu$  excluding the spiny outgrowths. The spores of the latter species give an amyloid reaction, turning blue in the presence of Melzer's chloral-iodine solution. This reaction is given by many species and is a useful aid in diagnosis.

---

tium centrifugum. 11. *Corticium calceum*. 12. *Corticium laeve*. 13. *Corticium salmonicolor*. 14. *Cyphella alboviolascens*. 15. *Cyphella punctiformis*. 16. *Corticium karstenii*. 17. *Corticium confluens*. 18. *Corticium laetum*. 19. *Corticium polygonium*. 20. *Vuilleminia comedens*. 21. *Corticium aurora*. 22. *Septobasidium bogoriense*. 23. *Auricularia auricula-judae*. 24. *Epithele typhae*. 25. *Jaapia argillacea* (after Wakefield & Pearson, 1920). 26. *Cyphella pelargonii*. 27. *Ecchyna faginea*. 28. *Corticium vellereum*. 29. *Corticium albostramineum*. 30. *Tomentella echinospora*. 31. *Corticium polyporoideum*. 32–34. *Tomentella* spp. 35. *Corticium trigonospermum* (after Wakefield & Pearson, 1913). 36. *Pistillaria cardiospora*. 37. *Hypochnella violacea*. 38. *Pellicularia flavescens*. 39. *Cyphella* sp. near *C. citrispora*. 40. *Merulius lacrymans*. 41. *Phaeocyphella galeata*. 42. *Dacryopinax spathularia*. 43. *Platyglaea effusa*. 44. *Dacryomyces deliquescens*. 45. *Helicobasidium compactum*. 46. *Eichleriella spinulosa*. 47. *Femsjonia luteoalba*. 48. *Coniophora arida*. 49. *Aleurodiscus aurantius*. 50. *Aleurodiscus oakesii*. 51. *Aleurodiscus amorphus*. 52. *Aleurodiscus mirabilis*. With the exception of Nos. 7, 24, 25, 35, the spores are all drawn to the scale shown.

The spores of homobasidiomycetes germinate directly to give a mycelium, and are never septate. Those of heterobasidiomycetes may become septate (Fig. 6, 44, 47) and germinate by putting out a small process termed a secondary sterigma, from which arise in series one or more secondary spores (Fig. 6, 43, 46) which later give rise to the mycelium. This sequence of events was called "germination par renovation" by Patouillard. It is perhaps best translated as "germination by repetition" (Rogers, 1933, p. 183) but has also been known as "renovation" (Donk, 1931, in translation). The secondary spores are the same shape as the original basidiospore, but smaller. In *Exobasidium* and *Dacryomyces*, sessile secondary spores, or conidia, are formed by gemmation from the sides of the basidiospore, either singly or in chains. This process should not be confused with germination by repetition.

Donk's term ballistospore is sometimes used to designate "those spores of Basidiomycetes which are actively projected at maturity according to the specific mechanism studied and amply described by Buller in his *Researches on Fungi*. Ballistospores are found in Basidiomycetes with exposed hymenia, Uredinales, Tilletiaceae and Sporobolomycetaceae (comprising the genus *Tilletiopsis*)" (Derx, 1948, p. 468, translated; see also Nyland, 1949).

### Chlamydospores.

Though they are uncommon in the lower Hymenomycetes, chlamydospores are present in some species and should not be overlooked. They may be defined as large, asexual, resting spores, characterised by a thick, refractile wall and dense lipid contents. They occur in a terminal or intercalary position on the hyphae. The spore wall may be smooth or variously sculptured.

Chlamydospores are found in cultures of many wood-rotting Basidiomycetes, e.g. *Trametes serialis* group (Fig. 7, 3). Good examples may also be seen in the genus *Nyctalis*, one of the parasitic Agaricaceae. In *N. parasitica* the chlamydospores are smooth, and occur in the subhymenium (Fig. 7, 2). In *N. asterophora* they are stellate and occur in the tissue of the upper part of the pileus (Fig. 7, 1). This interesting genus has been well investigated by Buller (1924), Thompson (1936) and Ingold (1940).

In *Sebacina epigaea* (see McGuire, 1941, Pl. 2, figs. 18-19) the basidiospores may be transformed into resting spores resembling the chlamydospores of *N. asterophora*. In *Corticium laetum* intercalary chlamydospores are sometimes found.

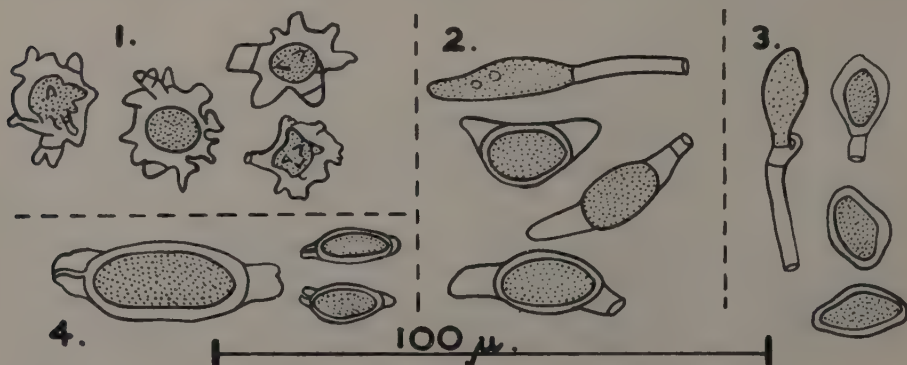


FIG. 7.—Chlamydospores:—

1. *Nyctalis asterophora*. 2. *Nyctalis parasitica*. 3. in culture of *Trametes serialis* group. 4. basidiospores of *Jaapia argillacea* with internal chlamydospores, the left-hand spore diagrammatic and not drawn to scale shown.



The basidiospores of *Jaapia argillacea* (Fig. 7, 4) may develop to contain a large, thick-walled, yellowish chlamydospore separated from the poles of the basidiospore by septa. Accounts of these structures have been given by Wakefield & Pearson (1920) and by Rogers (1935, Pl. iii, fig. 14).

### Hyphae.

The hyphae of the lower Hymenomycetes may be hyaline or coloured, thick- or thin-walled, with or without clamp connections, loosely or compactly arranged, with frequent or infrequent septa, and a variable degree of branching. Hyphae tend to branch most just beneath the hymenium. The hyphae range in width from a minimum of about  $1.5\ \mu$  in some species to a maximum of  $12\text{--}18\text{--}(29)\ \mu$  in species of the genus *Pellicularia*, e.g. *P. pruinata* (Bres.) Rogers ex Linder. The walls of gelatinised hyphae do not show distinctly except by special staining, and normally one sees only their filamentous, refractile lumen. The gelatinised walls may be stained with strongly ammoniacal methylene blue (Nannfeldt, 1947).

The colour of the hyphae appears to be significantly related to other structural characters, particularly to the development of setae and asterosetae (see p. 291).

Recently great strides have been made in classifying the types of hyphae encountered in the Polyporaceae (Corner, 1932 a; Corner, 1932 b; Cunningham, 1946). It has been shown that a similar classification may be applied to the hyphae of the Thelephoraceae (Banerjee, 1942). Corner (1932 a) defined four types of hyphae, viz. *generative*, *skeletal*, *binding* and *mediate* hyphae. In a second paper (1932 b) he defined the systems into which these types could be combined, namely *monomitic*, *dimitic* and *trimitic* systems, to form tissues. Cunningham (1946) extended this work and standardised the technique for examining hyphae. Largely on this basis, Cunningham (1947–1950) has classified and described the polypores of New Zealand.

### Hyphal types.

(1) Generative hyphae (Fig. 8, 1, 2): These are branched, thin-walled, septate, hyaline or coloured, with or without clamp connections, usually staining readily, and varying in width from about  $1.5\text{--}10\ \mu$ .

(2) Skeletal Hyphae (Fig. 8, 3, 4): These are of two general types, which Cunningham distinguishes as “bovista” and “long” types. The bovista type has a main axis  $3\text{--}10\ \mu$  in width, with several lateral branches which may in turn branch and taper. They are usually aseptate, and may be hyaline or coloured. The long type lacks the complexity of the bovista, and is slender,  $3\text{--}7\ \mu$  in diameter, septate or aseptate, branched or typically unbranched, usually thick- but sometimes thin-walled, hyaline or coloured and loosely interwoven.

(3) Binding hyphae (Fig. 8, 5): These also occur in the bovista and long forms. They are aseptate, interweaving, branched or sparingly branched, and thick-walled. As their name suggests they serve to consolidate the hyphae into firm tissues.

(4) Mediate hyphae: For practical purposes these need not be recognised. They are intermediate between generative and skeletal, and generative and binding hyphae, forming the transition from one to another of these types.

So far as the writer has been able to ascertain, “bovista” types of hyphae have not yet been found in the Thelephoraceae, though well known in the Polyporaceae. The “long” type of skeletal hypha is readily distinguished; not so the “long” binding hypha.

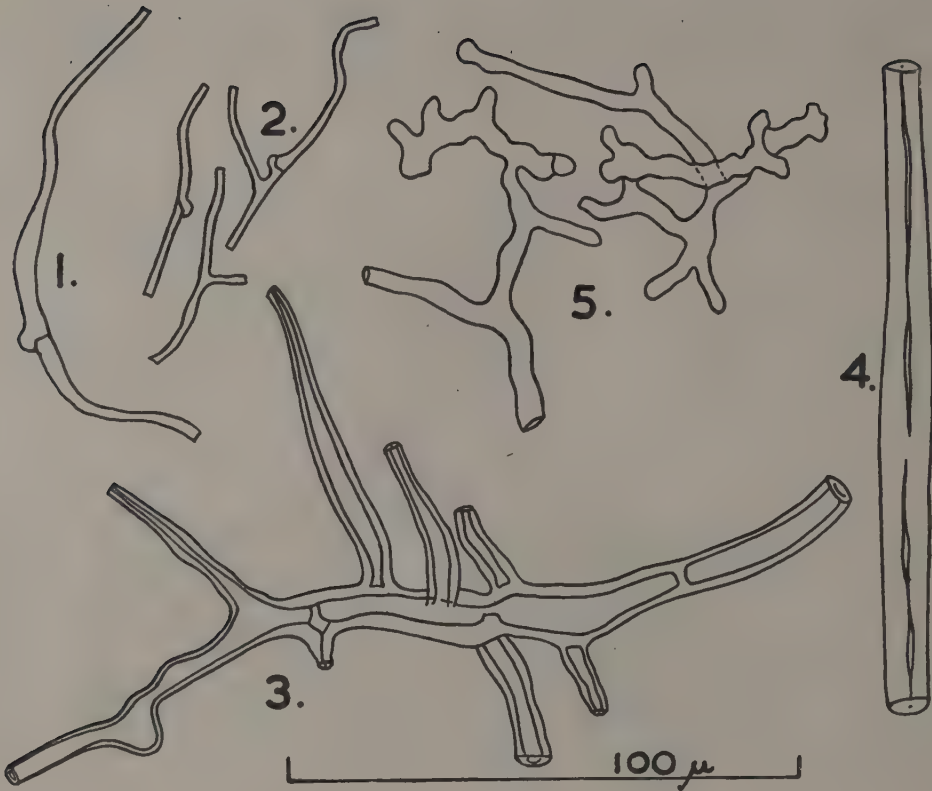


FIG. 8.—Hyphal types:—

A

1. Generative hyphae from *Polyporus angolensis*.
2. Generative hyphae from *Trametes serpens*.
3. Skeletal hyphae of the "bovista" type from *Polyporus sulphureus*.
4. Skeletal hyphae of the "long" type from *Polystictus pinsitus*.
5. Binding hyphae of the "bovista" type from *Polystictus pinsitus*.

#### Hyphal systems.

- (1) Monomitic: In this system there are only generative hyphae.
- (2) Dimitic: The system is composed of generative and skeletal hyphae.
- (3) Trimitic: Three hyphal types, generative, skeletal and binding hyphae, are present.

Cunningham (1946) has made several useful generalisations which help in deciding the kind of hyphal system present in a specimen. Thus: If all the hyphae are of one kind, or all possess clamp connections, the system is monomitic; if clamps are present in species with coloured hyphae of more than one type, the system is trimitic; clamps are absent from species with coloured hyphae and a dimitic system; clamps are usually present in the generative hyphae of hyaline dimitic systems. Cunningham has shown that the presence or absence of clamps is significantly connected with the hyphal types and systems.

Some clamp connections are illustrated in Fig. 8, 1, 2 and Fig. 9. The cytology of clamp connection formation is reviewed by Rogers (1936), where it is shown that clamps may be concerned in basidial proliferation as well as in a reproductive function



in the hyphae where they serve to "increase indefinitely the number of dikaryotic cells from which may be formed gonotoconts". Rogers also shows that the clamp is a homologue of the crozier of Ascomycetes, and gives evidence of the derivation of Basidiomycetes from Ascomycetes.

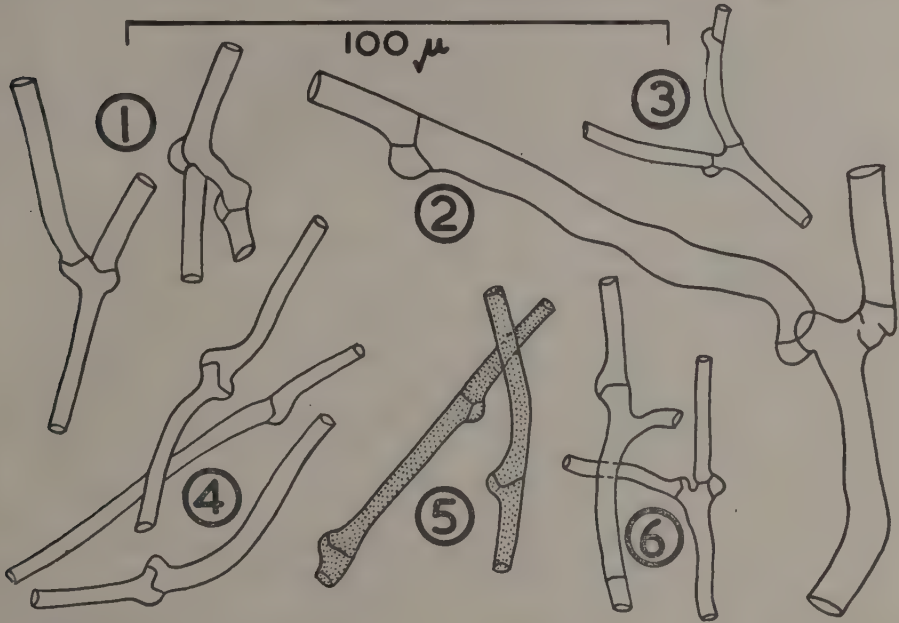


FIG. 9.—Clamp connections in:—

1. *Stereum schomburgkii*. 2. *Pellicularia subcoronata*. 3. *Odontia arguta*.
4. *Corticium armeniacum*. 5. *Stereum bicolor*. 6. *Corticium gloeosporum*.

#### Hyphal pegs.

These are erect, wartlike, papillate, tubercular or spiny structures projecting from the hymenium and often big enough to see with the naked eye. They are composed of sterile hyphae arising in coherent fascicles from the subhymenial or deeper tramal tissue. The thelephoroid forms bearing hyphal pegs might mistakenly be classed in the Hydnaceae without checking that the pegs are sterile.

The term "hyphal peg" has been commonly applied only to the Polyporaceae, in which group the sterile tufts of hyphae project into the lumen of the tubes (Fig. 10, 1). Overholts (1929) commented that hyphal pegs were never found in the genera *Fomes*, *Daedalea* and *Lenzites*, nor in species with brown context, nor in the soft, white species of *Polyporus*, nor in true species of *Poria*. He found that they were common in *Polystictus*, were present in some species of *Favolus*, and in *Trametes serpens*, and were very large in the genus *Mycobonia*. A common South African species, *Trametes meyenii*, bears abundant hyphal pegs in most collections. Bose (1944) noted that hyphal pegs, common in certain species at high altitudes, may be scarce or absent in the same species at low altitudes.

As was done by Rogers (1935, p. 25) and Banerjee (1942), it seems desirable to extend the term "hyphal pegs" to include the strictly comparable structures found not only in the Polypores but also in the Thelephoraceae. In the latter group they have

been variously known as "sterile emergences" (Patouillard), "emergent fascicles of hyphae" (Burt, 1919), or "cystidiform synnemata" (Langeron, 1945). As a synnema implies a fructification it should be avoided as a term for these sterile aggregations of hyphae.

Sometimes the presence of hyphal pegs has been the basis for splitting off new genera (e.g. *Dendrothele* separated from *Aleurodiscus*: cfr. Rogers, 1935, p. 25); at other times they are regarded only as useful confirmatory specific characters. Generic distinctions involving hyphal pegs have been based on their hyphal composition and upon their arrangement either as discrete spines or, extending the conception, as confluent into sterile linear ridges or shallow poroid networks. To illustrate the use of hyphal pegs in taxonomy some of the series which are apparent are set out in key form below, but in doing so no close affinity of genera is implied:—

A.—Hyphal pegs discrete.

1. Pegs formed of coloured hyphae. Fructification dimidiate or sessile, but not resupinate *Veluticeps*.
2. Pegs formed of colourless hyphae.
  - (A) Basidia tremelloid; texture sometimes subgelatinous..... *Heterochaete*.
  - (B) Basidia claviform.
    - (a) Pegs composed of delicate, much branched and interwoven dendrophytic hyphae, which are also present in the hymenium. *Dendrothele* (Fig. 10, 3).
    - (b) Pegs composed of delicate ordinary hyphae, little branched or slightly forked, and arranged more or less parallelly.
      - (x) Fructifications resupinate, lacking a well developed intermediate layer between substratum and hymenium *Epithele* (Fig. 10, 2).
      - (y) Fructifications pileate, sessile or shortly stipitate, or if resupinate then having a broad intermediate layer *Mycobonia*.

B.—Hyphal pegs united linearly..... *Grammothele* (see below).

C.—Hyphal pegs united to form shallow networks..... *Hymenogramme* and *Porogramme* (see below).

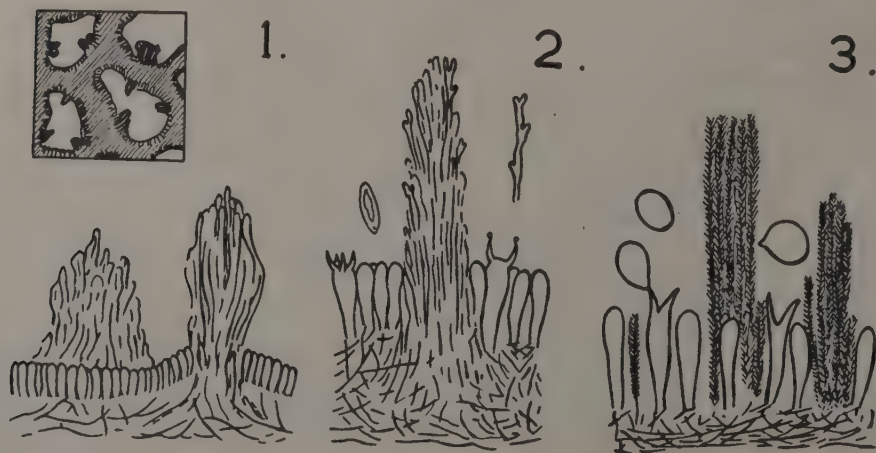


FIG. 10.—Hyphal pegs from:—

1. *Trametes meyenii*, inset showing a cross section of the pores. 2. *Epithele typhae*. 3. *Dendrothele* (after Höhnelt & Litschauer, 1907). All diagrammatic.



*Veluticeps* was regarded as a synonym of *Hymenochaete* by Killerman (fide Ainsworth & Bisby, 1945), but is used by Burt (1919, p. 259) in the sense given above, and is distinguished by him from *Mycobonia* by its coloured pegs. Malencon's (1939) description and illustrations of *Veluticeps heimii* show clearly that it is structurally quite distinct from *Hymenochaete*, a fact which Patouillard (1894) correctly observed.

One may imagine hyphal pegs to be united laterally so that sterile ridges, or pores surrounded by sterile walls, are formed over the surface of the hymenium. Two genera, which when mature have a hymenium covered with small, sterile, poroid ridges, are *Hymenogramme* and *Porogramme*. Patouillard (1899) states that *Porogramme* differs from *Hymenogramme* in having pores which are isodiametric instead of elongated as in the latter. They are genera which are insufficiently known to pass further comment on their structure. Lloyd (1923, p. 1232) has suggested that *Hymenogramme* should be united with *Grammothele*.

The genus *Grammothele*, though still imperfectly understood, requires comment. The hymenium is covered with ridges which are sometimes quite regular and linearly arranged, though not necessarily continuous (e.g. in *G. liniata* and *G. polygramma*), or sometimes more tubercular and irregular (e.g. in *G. mappa*, *G. pseudomappa* and *G. cineracea*). Through these ridges there project erect sheaves of hyphae surrounded and capped by large aggregations of minerals which cause a distinct glitter. These hyphae are very dilutely coloured and roughly parallelly arranged, not branched, and together with their sheaf of minerals form a type of hyphal peg resembling a very large cystidium at first sight (Fig. 16, 12). In *G. cineracea* these sheaves are branched and the branchlets terminate in mineral caps. The hyphal pegs in *G. mappa* are more often immersed than emergent.

The genus *Gloiothele* (Bresadola, 1920), founded on *Poria lamellosa* P. Henn., may be defined as a *Grammothele* possessing gloecystidia. The conformation of the hymenium resembles that of *Heterochaete*, but there are holobasidia and a crystal incrustation of the hyphal pegs as found in *Grammothele*.

### Ampoule hyphae.

In some lower Hymenomycetes, e.g. *Grandinia farinacea* and species placed by Bourdot & Galzin (1928) in the section Humicola of the genus *Corticium*, a number of hyphae become swollen into shapes resembling ampoules (Fig. 11). These are not always easy to find, and appear to be less obvious in material which is not fresh. Ampoules are generally associated with clamp connections, which here and there become much enlarged as the hyphae on one or both sides of the clamps become inflated and bulbous. When ampoules develop on both sides of a clamp, they meet obliquely in the middle. Sometimes the ampoule is viewed from a position where no sign of a clamp is present (Fig. 11, 3). Such structures seen alone might be confused with intercalary vesicles in the sense used elsewhere in this paper.

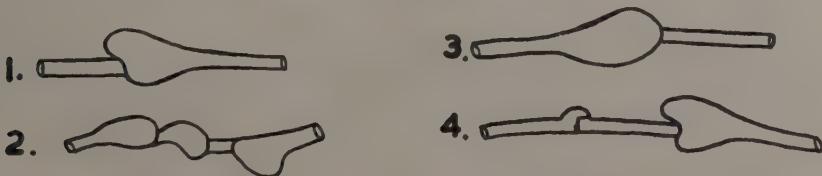


FIG. 11.—Ampoule hyphae drawn diagrammatically from:—  
1-3. *Corticium confine*. 4. *Corticium fastidiosum*.

The species of *Corticium* grouped in the section *Humicola* are not related solely by the possession of ampoule hyphae. They have other characters in common which suggests that the grouping is a natural one, e.g. a rather pellicular or farinaceous hymenium bearing veinlike mycelial strands or granules, and spores which are usually sculptured.

#### Conducting hyphae.

In many Hymenomycetes the context contains, in addition to the usual hyphal systems, a network of special hyphae with dense contents, which are known as conducting or laticiferous hyphae. In their best-developed form they are seen to be of indeterminate length, much branched, anastomosing, of wide diameter, relatively thinwalled, at first non-septate and coenocytic but later becoming sparsely septate. The dense sap may be hyaline, milky or brightly coloured, and in some species changes colour on exposure to light and air. Such hyphae are reminiscent of the latex tubes of higher plants. Their contents stain easily with Melzer's chloral-iodine, or with phloxine. In some species the sap is coagulated by alcohol (especially in *Agarics*). Such conductors may be up to  $24\ \mu$  in diameter. They are characteristic of the genus *Lactarius* (Fig. 12, 2), and are present in some species of *Mycena* and *Collybia*, and in some polypores, e.g. *Polyporus sulphureus* (Fig. 12, 1). Heim (1936) has studied the conducting systems of several *Agaric* species and gives excellent illustrations of them.

Little appears to be known about the composition of the sap of conducting hyphae. This would probably be a clue to their function, which is generally supposed to be the conduction of nutrient emulsions. Conductors are present in the rhizomorph of *Armillaria mellea* and if their function is nutritive it might explain in part the success of rhizomorphs in penetrating far into unfavourable situations, this action being assisted

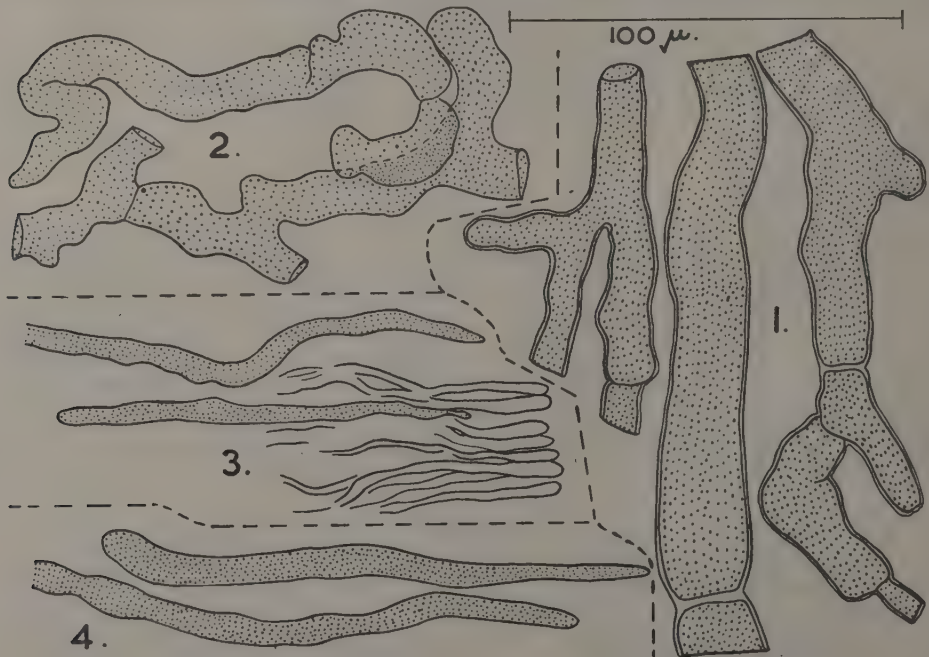


FIG. 12.—Conducting vessels of:—

1. *Polyporus sulphureus*. 2. *Lactarius deliciosus*. 3. *Stereum spadiceum*. 4. *Corticium lactescens*.



by their sclerotic rind. Confirmation of this supposition is given by Findlay's (1951) account of nutrients being transported distances of up to thirty feet along the rhizomorphs of *Armillaria mellea*.

Conducting hyphae as described above are distinguished from gloeocystidia by the fact that the latter are unbranched and limited in length. In *Hydnum erinaceum*, long yellowish conductors in the tissues of the spines curve out into the hymenium and their appear like gloeocystidia. The distinction between conductors and gloeocystidia is not so obvious in another type of conducting hypha found in several species of *Stereum* (Fig. 12, 3) which exude reddish juice on being bruised, and in *Corticium lactescens* (Fig. 12, 4), which exudes a milky juice when fresh. Here the conductors are comparatively narrow (4–9  $\mu$  diam. in *Stereum spadiceum*), apparently unbranched or very sparsely branched and relatively limited in length. Their connection with any extensive network of conductors is obscure, if in evidence at all. In fact it is usual to say that *C. lactescens* has gloeocystidia, though Miss Wakefield (1935) has pointed out that these are the terminations of a system of conducting hyphae. Perhaps, then, the best criterion of a conductor is that its contents exude when it is broken across and are often brightly coloured, added to the fact that the contents are very dense and that the conductors are long and indeterminate in length.

### Vesicles.

Vesicles are pyriform or subglobose, hyaline, thinwalled swellings, usually borne terminally but occasionally in an intercalary position on the context hyphae. In section they may appear devoid of contents, or filled with a homogeneous, or globular or granular, matter which stains deeply with phloxine. They occur typically in the trama, and are conspicuous objects when numerous or large. They are figured in this situation by Overholts (1929) and Burt (1920), pp. 125–134, figs. 13–16) for certain species of *Stereum*. The vesicles seen in *Stereum murrayi* (Fig. 13, 2) and *S. purpureum* (Fig. 13, 1) illustrate typically what is meant by this term. Miss Wakefield (1911) described the vesicles found in *Grandinia mucida*.

Structures similar to vesicles, but smaller, may be found with some difficulty in the pore tissues of certain polypores, e.g. *Polyporus subiculoides* (Fig. 13, 3) and a species of *Poria* near *P. mucida* (Fig. 13, 4). These are immersed in the subhymenium and are probably better referred to as cystidia than vesicles. They are comparable with the cystidia of *Odontia bicolor* (Fig. 16, 13), which, however, have a crystalline crown.

To the writer there is little doubt that vesicles are a form of gloeocystidium, judging not only from their position in the fructification but also from their general morphology: there is also the observation that in *Stereum murrayi* they are seen intergrading from the typical pyriform shape of vesicles to the typical elongated shape of gloeocystidia, with simultaneous change of their contents from homogeneous to granular or globular. The gloeocystidium of *Corticium polygonum* (Fig. 17, 13) may equally well be considered as a vesicle with dense, granular contents. In *Stereum murrayi* at least, it would seem that vesicles devoid of contents have simply lost their contents in the sectioning and mounting treatment. If the organs are short, swollen, and without very dense contents the tendency is to call them vesicles; if elongated they may be called gloeocystidia.

Three types of structure which might be confused with vesicles are worth mentioning. Firstly the short, dumpy basidia of species of *Amauroderma* (Fig. 13, 5–6) may easily be mistaken for vesicles or gloeocystidia in crush mounts if sterigmata are absent. Secondly in some species (e.g. *Stereum hirsutum*) when surface scrapings of the hymenium are made for mounting, one often cuts transversely across the underlying hyphae, obtaining a structure which appears like a refractile, thickwalled globose cell in optical section (Fig. 13, 8). It is well to emphasise that vesicles are thinwalled and larger.

Thirdly, some species (e.g. *Daedalea biennis*) have conidia embedded in the tissues (Fig. 13, 7). These are small, subglobose or ovate, and appear thickwalled owing to the presence of a large, dilutely coloured guttule. They arise from very delicate hyphae which are seldom seen, but whose presence may be inferred from fragments still attached to the conidia making them appear apiculate.

In a compact trama empty spaces are sometimes left when vesicles collapse.



FIG. 13.—Vesicles and structures resembling them:—

1. Tramal vesicles in *Stereum purpureum*. 2. Tramal vesicles in *Stereum murraili*, showing variation towards gloecystidia. 3. Hymenial cystidia in *Polyporus subiculoides*. 4. Hymenial cystidia in *Poria* sp. nr. *P. mucida*. 5-6. Immature basidia of *Amauroderma* spp. 7. Conidia embedded in the subhymenial tissue of *Daedalea biennis*. 8. Cross section of thickwalled hyphae from *Stereum hirsutum* and part of a hypha to show their origin.

### Coscinoids.

This term was given by Singer (1947, pp. 155-157) to the hyphae in a peculiar type of conducting system in *Paxillus lateritius*, on the basis of which he erected a new genus, *Linderomyces*, to accommodate this species.

Coscinoids are long, filamentous, brown, aseptate, non-clamped hyphae, with a pitted sieve-like surface and a sponge-like interior. The surface perforations are the orifices of a system of meandering tunnels of the same diameter as the orifices, and separated by a wall substance coloured deep brown. The whole structure is sponge-like and thus distinct from all other types of conducting system. When found in the hymenium, these structures were referred to by Singer as "coscinocystidia". Fragments of coscinoids are illustrated in Fig. 14.





FIG. 14.—Fragments of coscinoids drawn semidiagrammatically from the type of *Paxillus lateritius* in Kew Herbarium.

### Paraphysoid structures.

A number of sterile accessory hymenial structures are often grouped for convenience under the general name of *paraphyses*, though they are a heterogeneous collection and probably not homologous with the paraphyses found in Ascomycetes, to which group the term is sometimes restricted. For that reason the various types are sometimes distinguished as *pseudoparaphyses* and subdivided according to their form, but the terminology has been used in somewhat different senses by different authors.

In many of the Agaricaceae and in some of the Thelephoraceae there are hymenial cells which separate and support the basidia in such a way that the efficiency of basidiospore projection is increased. Langeron (1945, p. 323) terms these cells *pseudoparaphyses* or *basidioles*, and considers that they are merely aborted basidia. Miss Wakefield (1935) noted that in species showing differentiation of tissues resulting from a compact growth form, it is possible that some of the terminal cells of the hyphae remain permanently sterile and serve only to space out the basidia. Such sterile cells may acquire a distinctive form and be known as paraphyses; if they are indistinguishable from immature basidia they may be known as basidioles. It is possible that by mathematical analysis in the manner of Corner (1947; 1948 a) proof may be obtained whether these cells termed basidioles might have assumed the function of basidia or not. On the other hand there are sterile interbasidial cells which differ entirely from those just mentioned, and which are conspicuous enough to be classified and to be used as specific characters in taxonomy. Miss Wakefield (1935) observes that the distinction between paraphyses and cystidia is not always very clear, and that in practice the more or less elongated, filiform structures are liable to be called paraphyses and the stouter bodies cystidia. The distinction at present is one of form rather than of development or function. At present the emphasis must be on morphology alone, for our knowledge of the function and development of all such structures is almost negligible. Certain elements grouped here as *paraphysoid structures* are allied to basidia, cystidia, gloecystidia or hyphae in morphology, but may likely bear no close relationship to any of these.

The various forms grouped as paraphysoid structures in the Hymenomycetes (excluding Agaricaceae) will be considered now, following the usage proposed by Pilát (1926) with slight modification. We shall endeavour to point out where this differs from the usage of other authors, so that some uniformity may result.

(1) *Simple paraphysoids* (Fig. 15, A).—These are colourless, cylindrical or filiform, elongated, unbranched, rarely septate, smooth, thinwalled, straight, flexuous or spirally twisted elements which are prominent in the hymenium. In form there is often little to distinguish them from hyphae or immature basidia or cystidioles. It may be that their form can change in a manner analagous to that described by Bose (1940), who observed that different moisture conditions could convert regular basidia of some

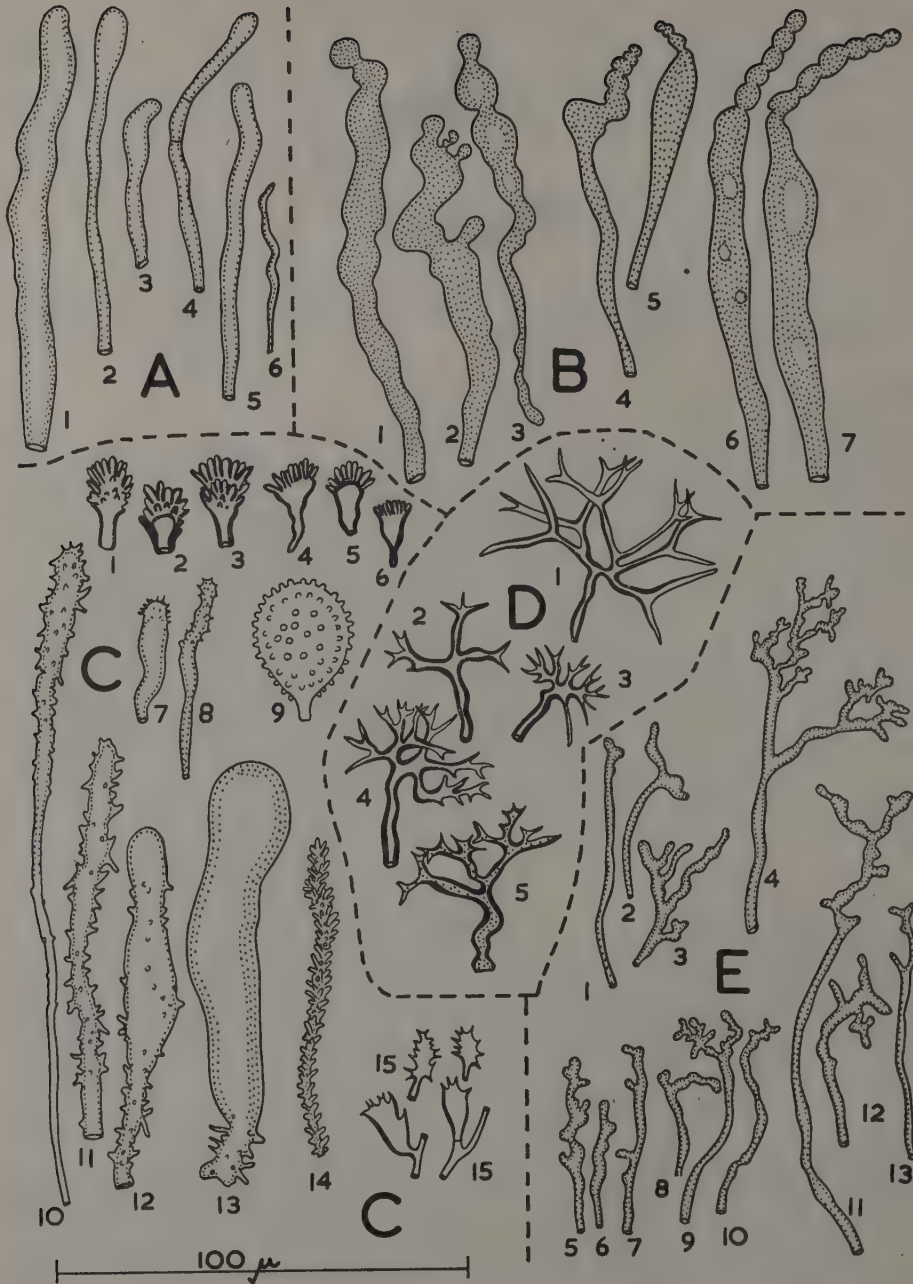


FIG. 15.—Paraphyses and paraphysoid structures:—

Group A.—simple paraphyses from 1. *Aleurodiscus mirabilis*. 2. *Aleurodiscus amorphus*. 3. *Aleurodiscus* sp. 4. *Aleurodiscus amorphus* (after Burt, 1918). 5. *Aleurodiscus oakesii* (after Burt, 1918). 6. *Corticium confluens*. Group B.—

polypores into hyphal elongations, and *vice versa*. The distinction between simple paraphysoids and dendrophyses in such species as *Corticium roseum* Pers. and *Corticium confluens* (Fig. 15, A, 6 and 15, E, 13) is merely one of degree of branching. In these species there is no fundamental difference, and their simple paraphysoids and dendrophyses are only different stages in development of the same type of organ.

Simple paraphysoids were included as paraphyses by Pilát (1926), and by Höhnelt & Litschauer (1907); they were distinguished as flexuous or spirally twisted paraphyses by Burt (1918); in some senses they were termed pseudoparaphyses or basidioles by Langeron (1945).

(2) *Pseudophyses* (Fig. 15, B).—These structures are thinwalled, not septate, hyaline, unbranched or occasionally forking slightly (Fig. 15, B, 2), somewhat clavate and constricted especially near the apex into a number of bead-like parts. The cells are homogeneous and stain deeply with phloxine. They would appear to be a form of gloeocystidium, and the term used by Bourdot & Galzin (1928), *torulose gloeocystidia*, is probably far more accurate than their description as a form of paraphysis.

Pilát (1926), Höhnelt & Litschauer (1907), Singer (1945), Langeron (1945) and Wakefield (1945) all termed these structures pseudophyses. Burt (1918) and Overholts (1929) called them moniliform paraphyses. De Bary (1887) described them as "narrowly filiform hairs often constricted like a rosary".

(3) *Acanthophyses* (Fig. 15, C).—Pilát (1926) introduced this term for the peculiar form of dendrophysis which is clavate or cylindrical and decorated with a number of short, pin-like outgrowths chiefly near the apex. He specified also that this term included Burt's (1918) "bottle-brush paraphyses", such as are common in many species of *Stereum* and *Aleurodiscus*.

We have here extended the circumscription of this term to include an assortment of paraphysoid structures all characterised by bearing short, pin-like outgrowths, but probably differing widely in origin and function. For example, Singer (1945) compared the "dendrophyses" of *Favolaschia* (cfr. Fig. 15, C, 9) with the "cellules en brosse" of some Agaricaceae, and found that they belonged to different types. In a wide sense, however, both might be included as acanthophyses following the conception given here. In *Favolaschia* these cells occur both on the sterile surface of the pileus and in the hymenium; in Agarics they are on the upper surface of the cap only. *Cellules en brosse* have also been termed "digitate cystidia" (Corner, 1948 b, p. 243). While observing the somewhat similar morphology of *cellules en brosse*, which might be considered as acanthophyses with swollen bases, and other acanthophyses, it is felt that the former term is useful in its application to the Agaricaceae, since these cells do not occur in the hymenium.

---

Pseudophyses from : 1-3. *Aleurodiscus amorphus*. 4-5. *Aleurodiscus aurantius*. 6-7. *Aleurodiscus oakesii*; Group C.—Acanthophyses and related structures. 1-3. "cellules en brosse" from *Marasmius* (*Androsaceus*) *epiphylloides* (after Conrad & Maublanc, 1924-1933). 4-6. "cellules en brosse" from *Marasmius* sp. 7-8. Acanthophyses from *Aleurodiscus oakesii*. 9. from *Favolaschia pezizoidea* (after Singer, 1945). 10-13. from *Aleurodiscus mirabilis*. 14. from *Aleurodiscus farlowii* (after Burt, 1918). 15. A group of four "cockroach cells" from *Aleurodiscus weirii* (after Burt, 1918): Group D.—Dichophyses from 1. *Asterostromella investiens*. 2-5. *Asterostromella* sp.: Group E.—Dendrophyses from 1-3. *Aleurodiscus oakesii*. 4-7. *Aleurodiscus* sp. 8-10. *Aleurodiscus aurantius*. 11-12. *Aleurodiscus amorphus*. 13. *Corticium confluens*. All drawn to scale shown except Nos. A, 4, 5; C. 1-3, 9, 14, 15.



In the sense used here acanthophyses are hyaline cells with hyaline or occasionally dilutely coloured pin-like processes. They occur in the hymenium. They may have thickish walls and be cylindrical or clavate, resembling some forms of cystidia (Fig. 15, C, 10–12), or thinwalled with a few basal processes (Fig. 15, C, 13) and in this case may be modified basidia. In some species (Fig. 15, C, 14) they possibly represent a modified hypha.

Pilát (1926) appears to have restricted the term acanthophysis to the bottle-brush type of paraphysis, or to forms very similar to it. This usage is followed by Overholts (1929) and Wakefield (1935). Höhnelt & Litschauer (1907) and Langeron (1945) grouped such forms as dendrophyses, and in part Singer (1945) did the same, e.g. in *Favolaschia*. Included in our conception of acanthophyses are elements which Bresadola named “cystidia corniculato-pinnata”, and those which Burt (1918) described as paraphyses with aculeate prongs, bottle-brush paraphyses, and cockroach-shaped paraphyses” (Fig. 15, C, 15).

(4) *Dichophyses* (Fig. 15, D).—This term was introduced by Pilát (1926) for a special form of dendrophysis distinguished by its more or less regular dichotomous branching. They are clearly seen in species of *Asterostromella*, also in *Stereum albobadium*, “*Stereum ayresii*” (“*S. midas*”), and in the genus *Dichostereum* Pilát or *Vararia* Karst.

Dichophyses are undoubtedly a form of hypha having rather thick walls, narrow lumina and subulate apices to the dichotomous branches. They are usually coloured and may occur in the hymenium or in the tramal tissues, or both. Only in the hymenium should they be considered for convenience as a type of paraphysis. Corner (1948 b, f. 8) shows clearly the origin of dichophyses in *Asterostromella* sp. as lateral branches of generative hyphae. Bourdot & Galzin (1928) emphasised their hyphal nature, referring to them as “corne de cerf” (deer-antlers), or dichotomous-divaricate or dendroid-branched hyphae. Höhnelt & Litschauer (1907) described them as “tree-like, branched cystidia”. Burt (1918) included them under the category of “granule-bearing paraphyses”. Wakefield (1935) mentioned Pilát’s usage.

(5) *Dendrophyses* (Fig. 15, E).—These are thinwalled, usually colourless, vaguely and irregularly but not dichotomously branched hyphae, which occur intermingled with other hymenial elements. Pilát (1926) restricted the term to paraphyses of tree-like form with irregular branching. Höhnelt & Litschauer (1907) did not distinguish between these and acanthophyses, naming both dendrophyses. Wakefield (1935) followed Pilát’s usage. Overholts (1929) termed those with short lateral branches “antler paraphyses”, though this description is usually reserved for dichophyses. Burt (1918) shows both dendrophyses and dichophyses under forms classed as “granule-bearing paraphyses”.

Dendrophyses occur in many species of *Aleurodiscus* (Fig. 15, E, 1–12), in some of *Sebacina* (e.g. *S. sublilacina*), and in various species of *Corticium*, especially the section *Aleurodiscoidea* of Bourdot & Galzin (1928), e.g. *Corticium roseum*. In *C. roseum* and *Corticium confluens* simple paraphysoids are found as well, and these differ from the dendrophyses only in being unbranched and presumably in a younger state (cfr. Figs. 15, A, 6 and 15, E, 13).

### Cystidioles.

A cystidiole is defined by Ainsworth & Bisby (1945) as “a sterile structure in the hymenium, at the same level as the basidia, wider than a paraphysis, thin walled and little differentiated”. They are usually inconspicuous, colourless, subulate or fusoid, often with a sharply pointed apex, thinwalled, sometimes finely encrusted, or smooth, sometimes projecting a short distance above the basidia. Usually they have no septa, but in *Corticium gloeosporum* an occasional subapical septum may be found. In *Stereum purpureum* cystidioles seem to appear under wet conditions, giving rise to the

form once known as *S. rugosiusculum*. There has been some doubt whether the corticioid forms bearing cystidioles should be classified under *Corticium* or under *Peniophora*. Thus on account of the cystidioles *C. sambuci* is sometimes classed as a *Peniophora*, while in *Peniophora cremea* the cystidioles are large and could well be called cystidia.

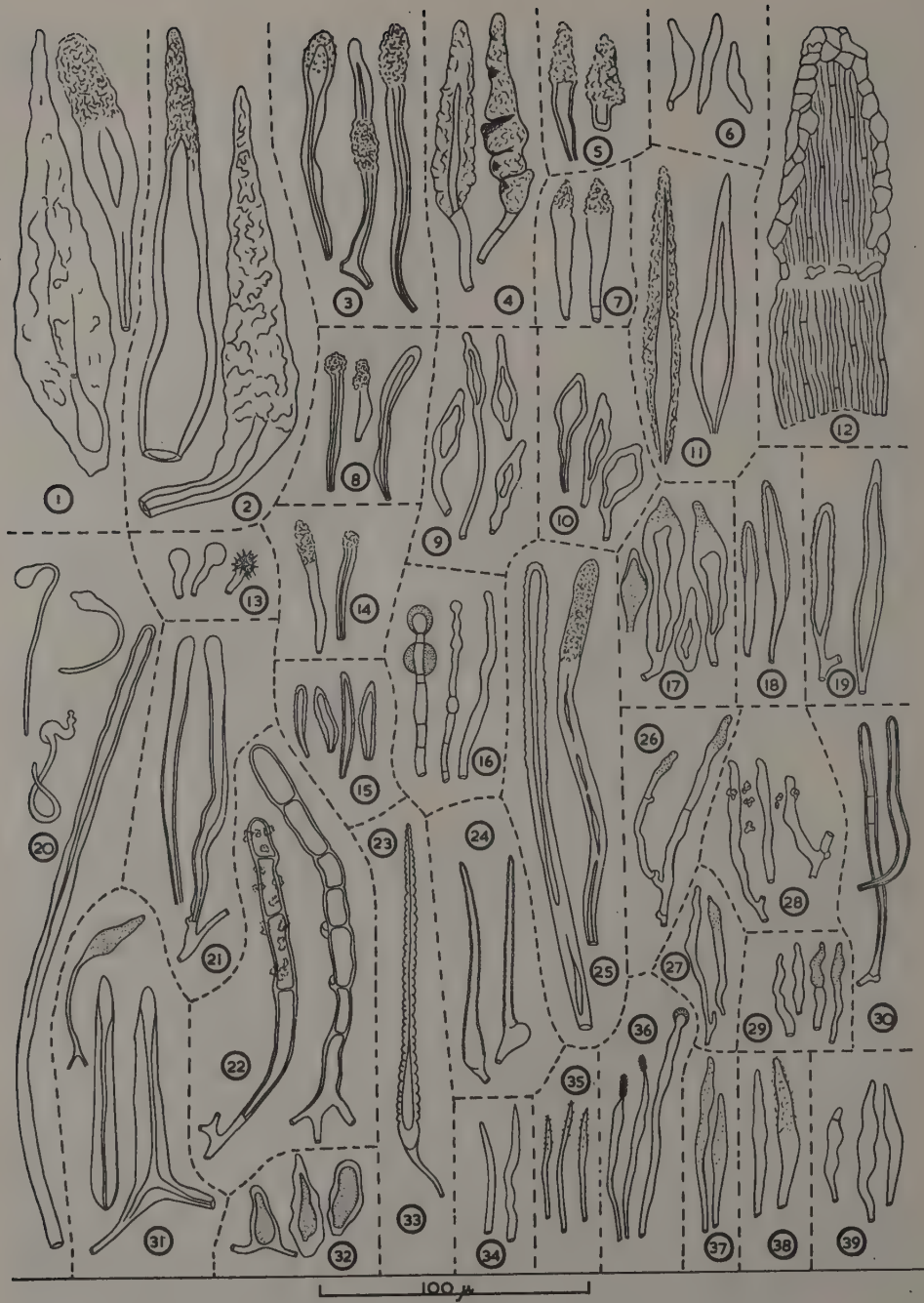
Among the species of resupinate Hymenomycetes bearing cystidioles are the following: *Corticium laeve*, *C. sambuci*, *C. ochraceofulvum*, *C. gloeosporum* (Fig. 16, 39), *Stereum purpureum*, *Peniophora cremea*, *P. sanguinea*, *Acia subceracea*, *Odontia crustosa* (Fig. 16, 34), *O. knysnana* (Fig. 16, 35) and *Hypochnella violacea*.

### Cystidia.

These are a rather heterogeneous assemblage of sterile bodies commonly occurring in representatives of the Agaricaceae, Polyporaceae, the genus *Peniophora*, and in certain species of the genera *Stereum*, *Odontia*, *Mycoleptodon*, *Cladoderris* and *Duportella*, to mention some of the better known. It is improbable that the so-called cystidia of all these groups are homologous, for they differ considerably in form, origin and probably in function. More information is urgently needed on these points, but for the time they are all discussed under the general category of cystidia. Many more studies such as those of Corner (1947) are needed, where it was shown that the cystidia of some species of *Clavaria* and *Oedemansiella* conform to the same mathematical equations as their basidia and are to be regarded as sterile, mostly precocious, overgrown basidia.

Certain generic segregates have been based on the presence of cystidia. For example *Peniophora* was segregated from other corticioid fungi originally on account of its "metuloids", but since then has included forms with very different cystidia; *Lloydella* was erected to include species of *Stereum* with metuloids; *Kneiffia* was ill-defined but its type species, *K. setigera* (= *Peniophora aspera*) has characteristic cystidia; *Heterochaetella* was segregated from *Sebacina* on account of its cystidia, and *Coniophorella* from *Coniophora* on the same grounds.

In the Agaricaceae, where the term "cystidium" originated with Montagne and was taken up by Leveille, the cystidia are sterile, hyaline, unicellular, ovoid cylindrical or clavate, blunt or pointed, smooth or ornamented or encrusted, originating as the terminal cells of branched hyphae and projecting from the hymenium. Buller (1924, pp. 52-53) classified them according to their position on the fructification, thus: *Pilocystidia* on the surface of the pileus; *Cheilocystidia* on the edge of the gills; *Pleurocystidia* on the sides of the gills; *Caulocystidia* on the stipe; *Dematocystidia* on the cuticle. Langeron (1945, p. 325, fig. 278) classifies the principal types of pleurocystidia giving examples of fungi in which they occur. There are five types, including those with spinous, barbed, crowned, and hooked apices, and those which have an encrustation resembling a muff round the middle of the cystidium. Langeron also noted a dimorphism in the cheilocystidia found on the large and small gills of some Agarics. The supposed functions of the cystidia in Agrics have been debated in various works, but it is difficult to ascertain the original source of some of these ideas. Cystidia have been thought to function as excretory hydathodes (Knoll) 1912. De Bary (1887) mentions that cystidia are often covered with slime, but observes that this condition is common in fungus cells rich in cell sap. Levine (1913, p. 161) considered that the cystidia in Boleti were modified basidia with a glandular function, excreting mucilage from their whole surface. Cystidia are also thought to have a mechanical value in maintaining the rigidity of the gills, in spacing adjacent gills apart, or in loosening appressed lamellae from the stipe. In the lower Hymenomycetes the pointed, encrusted "metuloids" were suggested to have a protective function against small animals feeding on the hymenium.





This study is more concerned with the cystidia of the lower Hymenomycetes (See Fig. 16), which again are very heterogeneous even in a single genus such as *Peniophora*. Thus it is impossible to give a general description of them. They may be conical or cylindrical in shape, or sometimes narrow and flexuous. The walls are sometimes characteristically thick and encrusted on the outside, but there are many species which have smooth, thinwalled cystidia. Some species, e.g. *Peniophora proxima* (Fig. 16, 15) have cystidia with finely sculptured walls. The lumen is usually narrow towards the apex, but in *Peniophora* section Tubuliferae (Bourdot & Galzin, 1928) the lumen is very narrow at the base and expands towards the apex of the cystidium. Incrustation of the walls may take the form of very fine amorphous, to large crystalline, deposits of mineral matter. In *Odontia bicolor* (Fig. 16, 13) the incrustation is in the form of druses of crystals, while in *Odontia arguta* (Fig. 16, 36) and *Peniophora pallidula* (Fig. 16, 16) the cystidia bear droplets of brownish resin. The small capitate cystidia of *Odontia bicolor* are similar in shape to those of *Polystictus subiculoides*, and resemble small vesicles except for their occurrence in the hymenium. Cystidia are usually hyaline, but if dilutely coloured then the colour resides in their walls and not in their contents. The contents are seldom well differentiated. In *Peniophora* section Gloeocystidiales (Bourdot & Galzin, 1928) the cystidia are smooth and thinwalled and have a fine, dense, granular content like that of gloeocystidia, but they originate in the basal part of the trama and project far beyond the hymenium, which according to Bourdot & Galzin distinguishes them from gloeocystidia. The distinction is not particularly clear.

The type of cystidium termed a "metuloid" by Cooke, is thickwalled, heavily encrusted and usually conical (e.g. Fig. 16, 1, 2, 4, 7, 17). They are sharply differentiated from the hyphae from which they rise. The smooth cystidia of *Peniophora* section Tubuliferae have a lumen which expands at the apex; they arise from the basal tissues and often have a forked base, and possess the curious property of dissolving in Potassium hydroxide solution so that only the shrunken cell contents are left behind. Examples are *Peniophora glebulosa*, *P. subalutacea*, and similar cystidia found in *Stereum karstenii* (Fig. 16, 31, 21, and 20 respectively). Septation is not usual in cystidia, but is very well seen in *Peniophora aspera* (Fig. 16, 22), *Coniophorella olivacea* and *Peniophora tomentella* (Fig. 16, 30). In the first species the cystidia also show occasional clamp connections.

The place of origin is probably important in classifying the types of cystidia encountered among the lower Hymenomycetes. Some cystidia are little modified from the hyphae from which they arise, e.g. *Peniophora tomentella* (Fig. 16, 30)

---

FIG. 16.—Cystidia and Cystidioles: Cystidia from the following species:—

1. *Stereum cinerascens*. 2. *Lopharia mirabilis*. 3. *Poria eupora*. 4. *Peniophora roumeguerii*. 5. *Peniophora pelliculosa*. 6. *Grammothele pseudomappa*. 7. *Duportella tristicula*. 8. *Poria obducens*. 9. *Cladoderris australica*. 10. *Cladoderris infundibuliformis*. 11. *Peniophora pubera*. 12. Hyphal peg from *Grammothele mappa* (type) resembling a cystidium. 13. *Odontia bicolor*. 14. *Daedalea quercina*. 15. *Peniophora proxima*. 16. *Peniophora pallidula*. 17. *Stereum involutum*. 18. *Peniophora laevis* forma *P. affinis*. 19. *Peniophora velutina*. 20. *Stereum karstenii* in acid and alkaline mounts. 21. *Peniophora subalutacea*. 22. *Peniophora aspera* (= *P. setigera*). 23. *Peniophora aegerita*. 24. *Peniophora longispora*. 25. *Irpex dregeanus*. 26. *Peniophora byssoidea*. 27. *Sebacina* sp. 28. *Odontia papillosa*. 29. *Sebacina sublilacina*. 30. *Peniophora tomentella*. 31. *Peniophora glebulosa*. 32. *Peniophora cinerea*. 33. *Peniophora aegerita*. Cystidioles from the following species: 34. *Odontia crustosa*. 35. *Odontia knysnana*. 36. *Odontia arguta*. 37. *Stereum purpureum*. 38. *Peniophora crenea*. 39. *Corticium gloeoporum*. All are drawn to the scale shown except Nos. 16, 23, 24, 31, 33.

*P. byssoidea* (Fig. 16, 26) and *Stereum umbrinum* (Fig. 19, 11–13). Others, especially the metuloid type, are sharply differentiated from the hyphae. Many cystidia originate from the base of the trama, e.g. *Peniophora glebulosa* (Fig. 16, 31), *P. subalutacea* (Fig. 16, 21) and *Stereum karstenii* (Fig. 16, 20). Especially in the *Coloratae* section of *Peniophora* (Bourdot & Galzin, 1928) the cystidia are arranged in stages throughout the trama, e.g. *P. proxima* (Fig. 16, 15) and *P. roumeguerii* (Fig. 16, 4). Still other cystidia arise in the hymenium or at least in the upper half of the trama, e.g. *Peniophora gigantea*, *P. longispora* (Fig. 16, 24), *P. byssoidea*, *P. pallidula*, and *P. pubera* (Fig. 16, 26, 16 and 11 respectively).

Illustrated in Fig. 16, 12 is the form of hyphal peg found in the trama of *Grammothele mappa*. At first it might be thought to be a large cystidium, but more careful observation reveals the core of erect sheaves of brownish hyphae capped by a heavy mineral incrustation (see also under Hyphal Pegs, p. 277).

### Gloeocystidia.

In Fig. 17 are shown a number of bodies found in species of many genera and all classed as gloeocystidia. These are sterile organs mainly distinguished by their thin walls, dense and deeply staining contents, lack of sculpturing and incrustation, and their position in the tissues of the fungus. The contents may be hyaline or lightly coloured, yellow to brownish; they are highly refractile, homogeneous or granular or globular, in the last instance usually of an oily nature. Commonly they arise from hyphae situated in the subhymenium or deeper tissues and may be completely embedded, or extend as far as the level of the basidia; only in a few species are they found projecting above the hymenium. Their walls are colourless. Any colour they may possess is located in the cell contents.

Gloeocystidia stain deeply with phloxine or eosin in potassium hydroxide mounts, and ones which are normally coloured take on a deeper, brownish colour with iodine solutions. Singer (1945) recommends the use of brilliant cresyl blue for differential staining of the contents and walls of gloeocystidia; with this stain the contents turn blue, while the walls are stained lilac.

In shape, gloeocystidia may be narrow, flexuous and subcylindrical, or wider and clavate, or uncommonly (e.g. *Corticium polygonum*, Fig. 17, 13) inflated and ovoid or pyriform. They are not branched. Septation is very rare but is known to occur in the gloeocystidia of *Duportella tristicula* (Fig. 17, 15), where a single subapical septum is sometimes seen. Many species show pseudoseptation of the gloeocystidia when mounted in glycerine, which causes the contents to contract (Overholts, 1929). The walls are normally smooth and not encrusted with mineral matter. However, in *Corticium pallidum* (Fig. 17, 12) the gloeocystidia are capped with a brownish resinous substance which is soluble in hot lactic acid but not in alkali (Höhnel & Litschauer, 1907).

Despite the distinguishing features outlined above, gloeocystidia may be confused with other organs in a few specific cases. Some examples are now given:—

- (1) In the genus *Aleurodiscus* the basidia are very large and stain deeply, thus immature basidia may be taken for gloeocystidia in crush mounts where the hymenial elements are displaced. Basidia of *Amauroderma* may also be taken for gloeocystidia or vesicles (see p. 279 and Fig. 13, 5–6).
- (2) The conducting hyphae of the bleeding species of *Stereum*, and of *Corticium lactescens*, do not form an obvious network, and their terminations may be thought to be gloeocystidia. Conductors exude their contents readily, whereas the contents of gloeocystidia usually cohere fairly well. In *Hydnum erinaceum* there are “gloeocystidia” in the spines which connect with an extensive system of conducting hyphae. They are part of one system and should not be differentiated.



FIG. 17.—Gloeocystidia from the following species:—

1. *Stereum diaphanum*. 2. *Stereum duriusculum*. 3. *Stereum* affine. 4. *Stereum involutum*. 5. *Stereum thozetii*. 6. *Stereum bicolor*. 7. *Corticium praetermissum* (= *Peniophora tenuis*). 8. *Corticium roseocremaeum*. 9. *Corticium coroniferum*. 10. *Corticium albostramineum*. 11. *Corticium luteocystidiatum*. 12. *Corticium pallidum*. 13. *Corticium polygonium*. 14. *Bourdottia cinerella* var. *trachyspora*. 15. *Duportella tristicula*. 16. *Asterostroma cervicolar*. 17. *Bourdottia eyrei*. 18. *Seismosarca* sp. All drawn with camera lucida, but scale varying.



- (3) Certain species of *Peniophora* (e.g. *P. sphaerospora*, *P. tenuis*) with non-encrusted, thinwalled cystidia which project above the hymenium, have frequently been classed as *Corticium* as there is some doubt whether these organs are cystidia or gloeocystidia. The tendency nowadays is to place these under *Peniophora*, for example Rogers & Jackson (1943) refer *Corticium praetermissum* (Fig. 17, 7) to *Peniophora* under the species *P. tenuis*. Again in *Stereum diaphanum* it is difficult to decide whether these organs are cystidia or gloeocystidia; they may be embedded or project above the hymenium.
- (4) Some cystidia, when mounted in alkali, have their encrustation dissolved away, and but for their position and thick walls may be confused with gloeocystidia. Numerous illustrations of this condition are to be found in Fig. 16, e.g. 6, 9, 10, 11, 17.
- (5) The vesicles in some species resemble gloeocystidia. See note on p. 279.
- (6) The pseudophyses (moniliform paraphyses) of species of *Aleurodiscus* are probably best considered as a form of gloeocystidium. See note on p. 283.
- (7) In *Stereum bicolor*, *Peniophora incarnata*, and some other species of *Peniophora* in the section *Coloratae* (Bourdot & Galzin, 1928) there appears to be a distinct intergrading of form between gloeocystidia and cystidia. This is well shown in *S. bicolor* (Fig. 17, 6). In most species where cystidia and gloeocystidia occur together, the two kinds of organ are distinct at all times. This bears on the origin of these organs, which will be considered now.

As gloeocystidia are probably not all homologous organs no generalisation is possible regarding their origin and function, and these aspects have only been studied in a very few species. In the species just mentioned, there is a definite intergrading from gloeocystidia to cystidia. Masee (1887) concluded that cystidia were the terminal growing points of laticiferous vessels, and that the young ones contained a hyaline, dense protoplasm which was later replaced by a finely granular substance which eventually escaped through an apical pore to nourish the spores. A very common idea was that gloeocystidia exude at the apex and become changed into encrusted cystidia in species such as *P. incarnata*. Present observations on *Stereum bicolor* (Fig. 17, 6) suggest that the whole wall of the gloeocystidium dissolves and that the contents, now very dense and coherent, remain as a highly refractile body which resembles a fragmented and encrusted cystidium. Whelden (1936) carefully studied the cystidia and gloeocystidia of *Peniophora livida* and concluded that the cystidia originated in the same way as basidia from the apex of an hymenial hypha, while the gloeocystidia arose laterally from hyphae near the substratum. In this fungus these organs were always entirely distinct from one another. Mention has already been made of Corner's work on the origin of cystidia on some species of *Clavaria* and *Oedemansiella* (see p. 285).

Nothing definite is known of the function of gloeocystidia, but it is likely that they are concerned in nutrition. Overholts (1929) suggested that they might have a protective function if their contents were unpalatable to animals.

Gloeocystidia are uncommon among higher Hymenomycetes, but are widespread among the genera of the lower Hymenomycetes. For example, they are found in many species of the genera *Aleurodiscus*, *Stereum*, *Corticium*, *Sebacina*, and *Asterostromella*. They form the so-called "colour cells" found in the genus *Favolaschia* (Singer, 1945). Their presence is the reason for splitting off new genera from old, e.g.

*Gloeocystidiellum* from *Corticium*, *Gloeopeniophora* from *Peniophora*, *Bourdodia* from *Sebacina*, *Seismosarca* from *Exidia*, and *Gloeotulasnella* from *Tulasnella*. This practice is now ceasing, and at the most the presence of gloeocystidia is given subgeneric significance.

### Setae.

Setae may be defined as sterile, rigid, dark-coloured, thick-walled, spine-like organs, usually having a more or less pointed apex, and possessing the property of darkening in alkali. Burt (1918, p. 302) drew attention to this chemical reaction as a fundamental way of distinguishing setae from similar structures such as elongated coloured cystidia (e.g. in *Stereum umbrinum*). Setae are yellowish- or reddish-brown in colour, and the pigment is located mainly in the walls. The lumen is usually narrow.

Simple, unbranched setae vary in size and shape, and in the character of their apices. Such variations are usually only of minor specific significance, for on the whole their appearance is fairly uniform. Compound setae are not common; they may assume bizarre shapes, but may be analysed as composed of a main axis united to branches which individually do not differ much from forms encountered among simple setae.

In different species, setae may be abundant or rare, emergent from the hymenium or embedded deeply, or found upon the cuticular surface.

Cunningham (1946) has studied the origin of setae in some species of polypores. They usually develop below the hymenium and project beyond the basidia. Cunningham states that they arise from skeletal hyphae in species with a dimitic hyphal system, and from generative hyphae in species with a monomitic system; they are absent from species with a trimitic system. However, as Corner (1932 b, p. 59) showed that the setae of *Fomes laevigatus*, a species with a dimitic system, arose from generative hyphae perhaps no generalisation is yet possible. With most setae it is extremely difficult to trace the type of hypha from which they arise.

Regarding the function of setae nothing definite is known, but it has been speculated that they may provide rigidity to the fructification and protect the tissues from damage by small animals. Overholts (1929) mentioned these speculations, but added that the function is probably far more fundamental. Considering that small animals provide a useful alternative to anemochory or water dispersal of spores of many resupinate Basidiomycetes (Talbot, 1952), the writer is inclined to minimise any protective function ascribed to setae, cystidia or gloeocystidia.

As with most other conspicuous organs, setae have been used in the erection of new genera, e.g. *Hymenochaete* Lév. and *Mucronoporus* Ell. & Everh. They are common in *Phellinus* Quél. and *Xanthochrous* Pat., are found in many species of *Poria*, and were estimated by Overholts (1929) to occur in 5–10 per cent of species of *Fomes* and *Polyporus*.

Of themselves, setae would not appear to have any generic significance. They are, however, associated with other characters which occur in a series of fungi at present classed in many different genera and families, and which seem to constitute a natural series. Donk (1933) refers to this series as the *Hymenochaetoideae*, a sub-family of the *Aphyllphoraceae*, while Corner (1948 b) calls it the *Xanthochroic* series. As Corner (1948 b, p. 235) expresses it, "These *Xanthochroic* fungi are distinguishable not so much by the *Hymenochaete* setae, which are absent from many of them, as by the character of their hyphae. The absence of clamp connections, the lack of inflation of the cells of the fruit body, and the ochraceous or brown colour of the hyphal walls, which darkens to ferruginous or date brown with alkali, distinguish these fungi".



FIG. 18.—Setae:—

1. Uncinate (hamate) seta from *Poria uncinata* (after Cunningham, 1946).  
 2. Ventricose seta from *Polyporus tabacinus* (after Cunningham, 1946). 3. Compound seta of *Polyporus gramocephalus* (after Cunningham, 1946). 4. Subulate seta (after Lowe, 1942). 5. Ventricose seta (after Lowe, 1942). 6. Setae from the hymenium of *Polyporus gilvus*. 7. from *Polyporus radiatus*. 8. from *Hymenochaete fasciculata* (type). 9. from *Poria contigua*. 10. from *Hymenochaete nigricans*.



This, and similar trends in classification are among the most significant to have arisen recently. The Friesian classification was based on macroscopic characters. Later with Patouillard (1900) came the first and greatest attempt to utilise microscopic characters in taxonomy, but the trend was then to give too much prominence to them, with the result that many genera became defined by single microscopic characters. The present tendency is to bring into their right perspective the wealth of microscopic characters which are already known, and through this to reveal a series of affinities which cut right across the classical groups. A more natural classification will result from this type of work, but only when more species have been scrutinised and more is known of the function of their microscopic organs.

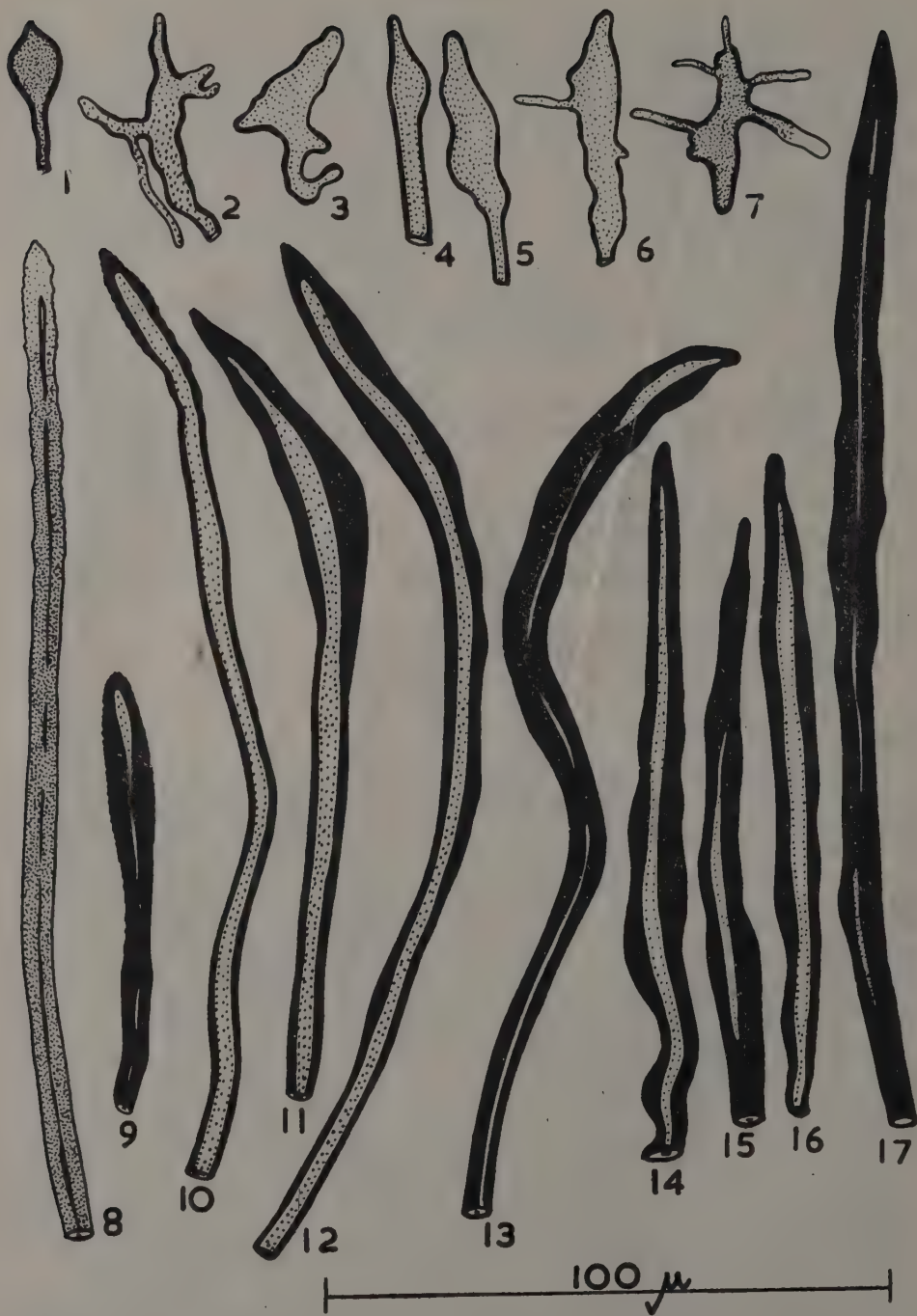
For the diagnosis of species, some of the differences seen in setae are the following:—

- (1) Size. Cunningham (1946) mentions a size range of 10–160  $\mu$  long and 6–12  $\mu$  wide.
- (2) Shape. Subulate (Fig. 18, 4), ventricose (Fig. 18, 2, 5), conical and elongated (Fig. 18, 8, 9) shapes are common.
- (3) Colour.
- (4) Apex. The apex is often sharply pointed, but sometimes blunt. It may be hamate or uncinata (Fig. 18, 1).
- (5) Position of the setae in the hymenium, trama or cuticle, and their relative abundance.
- (6) The type of hypha from which the setae arise.
- (7) Branching. Simple, or compound setae (Fig. 18, 13).

#### Setoid structures.

In certain species of resupinate Hymenomycetes and polypores, structures are found which resemble setae except that they are much more elongated and may differ in their origin. They are usually more cylindrical, of comparatively great length, and not limited in size and shape as is a well defined seta. This is because they are apparently only modified thickwalled skeletal hyphae. The lumen is usually very narrow, sometimes expanding a trifle towards the apex, which itself is frequently wider than the rest of the hypha. The apex may be minutely sculptured as in *Stereum schomburgkii* and *Duportella tristicula* (Fig. 19, 8–10). In other species the wall is quite smooth, e.g. in *Polyporus ochroporus* and *P. patouillardi* (Fig. 19, 14–17). In all these species the setoid structures darken slightly in alkali while the rest of the trama shows an even darker reaction. Similar structures occur in *P. tabacinus* (fide Cunningham, 1946). In some collections of *Stereum hirsutum* some of the hyphae though only very faintly coloured, have thick walls and a lumen which expands near the inflated apex in a way similar to that found in the species just mentioned. Pilát (in Hedwigia, Vol. 70) records some collections of *S. hirsutum* of this type. These structures are included here for comparison, but they do not darken in alkali and are not setoid structures. In *Stereum umbrinum* there are mineral-encrusted organs which are usually called cystidia (Fig. 19, 11–13) but which are frequently smooth-walled and might then be considered as setoid structures. They too are only modified skeletal hyphae and sometimes give a faint colour reaction with alkali.

- 
11. from *Polyporus carneofulvus* (type). 12. from *Polyporus ochroporus* (cotype).
  13. Compound cuticular setae from *Polyporus cuticularis*. 14. *Favolus megaloporus*.
  15. *Polyporus dryadeus*. All except Nos. 1–5 drawn to the scale shown.



A form of setoid structure differing from those already mentioned is found in the pore walls of *Polyporus dictyopus*. These terminate some of the hyphae. They take the form of a blunt, irregular axis with irregular, narrower lateral outgrowths. The axis is brown and darkens in alkali; the lateral outgrowths are paler and often almost hyaline at their apices (Fig. 19, 1-7).

### Asterosetae.

In the genera *Asterostroma*, *Asterodon*, and in some species of *Lachnocladium* there occur brown, stellate organs composed of several rays, each like a seta, radiating from a common centre which is sometimes expanded into a distinct boss. They terminate some of the laterals of generative hyphae, which, in *Asterodon*, also give rise to skeletal hyphae independently, and to extrahymenial setae and hymenial setae (Corner, 1948 b). The largest asterosetae occur towards the base of the fructification; they diminish progressively in size as the hymenium is approached. The rays of the asterosetae may be simple or branched in the same fructification. When they are branched, the organ is still regular in shape, and stellate. Asterosetae are related to ordinary setae in composition and basic structure, and may be regarded as a special form of compound seta. They darken in alkali and the species bearing them also show other indications of belonging to the Xanthochroic series, or Hymenochaetioideae.

Corner's work (1948 b) on the morphology and development of *Asterodon ferruginosus* is especially interesting in relating the shape and direction of the asterosetae to the forces controlling the growth and form of the fructification. Thus, in the resupinate part of the fructification there are evidently no form factors in operation and stellate setae are developed (Fig. 20, 6). In the hymenium the setae become simple, or those parts of the setae lying in the subhymenium become shortly substellate (Fig. 20, 7). In the spines, where a positive geotropism is in action, the setae lying in the context tissue are elongated downwards (Fig. 20, 8-10), while those near the hymenium where the factor responsible for lateral production of basidia is in operation, become drawn out into lateral branches simulating ordinary hymenial setae (Fig. 20, 10). As Corner expresses it, "The shape of the setae and the direction of the skeletal hypha express the action of the form-factors of the fruit body". This most significant work in interrelating these forms of setae provides a reason for the bewildering shapes which setae may assume.

### Mineral inclusions.

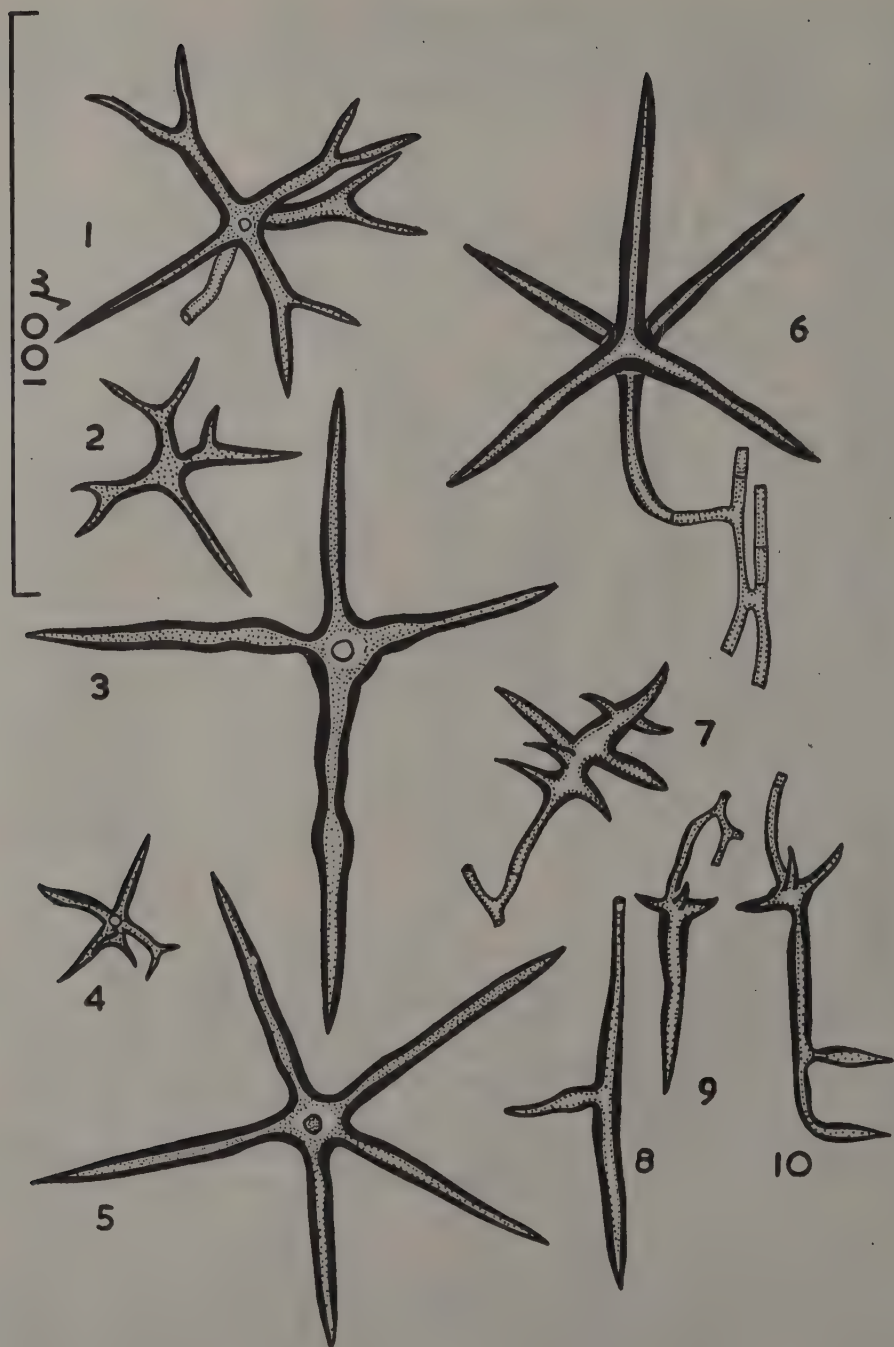
Very little is known about the chemical composition of the minerals which so commonly occur in the trama, or encrust the hyphae and other organs of fungi. Calcium oxalate is a common mineral found in the form of octahedra, acicular crystals or irregular nodules or granules; in fact most mineral substances found in fungi were once assumed to be calcium oxalate without further inquiry. Recent investigations into the metabolic products of fungi have shown that a vast number of organic compounds may be isolated from growing fungi and then crystallised.

Added to the mineral forms mentioned above, it is also common to find small mineral platelets, druses of crystals (e.g. in the trama and crowning the cystidia of *Odontia bicolor*), and large irregular concretions (e.g. in the trama of *Grammothele*

FIG 19.—Setoid structures:—

1-7. Hyphal terminations in the pore walls of *Polyporus dictyopus*. 8-9. Hyphal terminations in the hymenium of *Stereum schomburgkii*. 10. Hyphal terminations in the hymenium of *Duportella tristicula*. 11-13. Modified skeletal hyphae (cystidia) of *Stereum umbrinum*. 14-15. Setoid hyphae of *Polyporus ochroporus* (cotype). 16-17. Setoid hyphae from the pore tissue of *Polyporus patouillardii* (short examples).





spp.). Incrustation of the cystidia is particularly common in the genus *Peniophora*, and in species of *Stereum* which were at one time segregated as the genus *Lloydella*. Incrusted hyphae also occur in many species and are then an aid to specific diagnoses (e.g. in *Peniophora filamentosa* and *Polyporus rutilans* and *Coniophora betulae*). In *P. filamentosa* and *P. rutilans*, which but for the difference in hymenial configuration are identical, the crystals are rapidly soluble in potassium hydroxide solution and react to give a vinous colour. Some mineral inclusions are soluble in alkali, others in acid solutions, thus it is desirable to make mounts in more than one medium. Occasionally the mineral incrustation has its own bright colour which colours the whole fungus; more often the minerals are colourless or light yellowish and at the most impart a glitter to the surface of the fungus.

Large airspaces which are frequently observed in sections of fungi may be due to the former presence of mineral inclusions. These are sometimes torn out during sectioning as the razor comes up against the hard obstruction, or they may sometimes have been leached out prior to collection. It is possible that during its growth the fungus produces minerals in solution, which, with the advent of dry conditions, become deposited in the tissues as large concretions. On subsequent leaching of the trama these may be redissolved and thus leave an airspace.

#### Acknowledgments.

The writer was dependent upon the generosity of many authors and publishers for permission to reproduce illustrations of material which was not available, or unsuitable, for first-hand study. The following authors, publishers and editors of journals, as the case may be, co-operated most kindly in allowing the figures listed below to be copied. The writer tenders to them his sincere thanks:—

- The College of Forestry, State University of New York, Technical Publication No. 60; J. L. Lowe, *Polyporaceae of New York State*, Illustr. ii, 26.  
 Bulletin of the Torrey Botanical Club: G. W. Martin in Vol. 62 (1935), 341, Fig. 2, I. & J.  
 Lloydia: G. W. Martin in Vol. 11 (1948) 115, Fig. 1, 1 & 2 f.  
 R. Singer in Vol. 8 (1945) 209, Pl. 3, Fig. 9.  
 University of Iowa Studies in Natural History: D. P. Rogers in No. 16 (1934) Pl. 7, Figs. 3, 4, 21.  
 Mycologia: D. P. Rogers in Vol. 36 (1944) 81, Fig. 3; 97, Fig. 12.  
 G. W. Martin in Vol. 28 (1936) 215, Fig. 1, 9.  
 G. W. Martin in Vol. 31 (1939) 509, Figs. 12, 13.  
 L. Olive in Vol. 42 (1950) 389, Fig. 2, 17, 20, 21.  
 Annals of the Missouri Botanical Garden: E. A. Burt in Vol. 5 (1918) 181, Fig. 1, f; 184, Fig. 3, f; 183, Fig. 2; 203, Fig. 14, c & br.  
 British Mycological Society Transactions:  
 E. M. Wakefield in Vol. 4 (1913) Pl. 3, Figs. 3-5.  
 E. M. Wakefield & A. A. Pearson in Vol. 6 (1920) text Fig. on p. 320; in Vol. 8 (1923) 218, Fig. 4.  
 E. J. H. Corner in Vol. 31 (1948) 234, Fig. 1; 239, Fig. 5.  
 Journal of the Elisha Mitchell Society: W. C. Coker in Vol. 35 (1920) Pl. 55, Fig. 1.  
 University of North Carolina Press: J. N. Couch, "The genus *Septobasidium*" (1938) 351, Pl. 28, Fig. 1.

---

#### FIG. 20.—*Asterosetae*:—

1-5. from *Asterostroma cervicolor*. 6-10. from *Asterodon ferruginosus* (after Corner, 1948 b). 6. Stellate setae in the resupinate part of the fructification. 7. substellate setae near the subhymenium. 8-10. Setae in the tissues of the spines and emerging laterally into the hymenium on the spines (simple, forked or substellate setae). Nos. 1-5, only, drawn to scale shown.

Cambridge University Press: W. B. Grove, "The British Rust Fungi" (1913) 14, Fig. 16 a and b.

Department of Scientific and Industrial Research, New Zealand: G. H. Cunningham in N.Z. Journ. of Science & Technology 28 (1946) Figs. 7, 8, 9.

The writer is much indebted to the following persons for their assistance in locating the owners of copyright material: Prof. Roger Heim, Dr. D. P. Rogers, Dr. P. H. Gregory, Dr. Theodor Just, Dr. C. A. Berger, Prof. Ralph G. Unger, Dr. G. W. Martin and Dr. J. N. Couch.

The author's obligation to Dr. M. A. Donk must be apparent in the part of this paper dealing with basidial morphology, but he also wishes to record his thanks to Dr. Donk for making available much literature, for illuminating criticism of parts of the manuscript, and for every generous encouragement.

### Literature Cited.

- AINSWORTH & BISBY.. (1945). A Dictionary of the Fungi. 2nd Ed., I.M.I., Kew.  
 AMES..... (1913). Ann. Mycol. 11, p. 220.  
 BAKER..... (1936). Ann. Mo. Bot. Gard. 23, pp. 69-126.  
 BANERJEE..... (1942). Journ. Indian Bot. Soc. 21, pp. 33-39.  
 BODMAN..... (1938). Mycologia 30, pp. 635-652.  
 BOEDIJN..... (1937). Bull. Jard. Bot. Buitenzorg ser. iii, 14, pp. 187-196.  
 BOSE..... (1940). Nature 145, p. 706.  
 (1944). Journ. Indian Bot. Soc. 23, pp. 153-157.  
 BOURDOT & GALZIN.. (1928). Hyménomycètes de France. Soc. Myc. de Fr.  
 BRESADOLA..... (1903). Ann. Mycol. 1, Tab. 3, Fig. 1, c.  
 (1906). apud Rick in Broteria 5, p. 7.  
 (1920). Ann. Mycol. 18, p. 44, Fig. 3; p. 52.  
 BULLER..... (1909). Researches on Fungi, Vol. 1. Longmans & Co.  
 (1922). Ibid. 2, p. 31 and p. 157. Longmans & Co.  
 (1924). Ibid. 3, pp. 52-53 and pp. 446-463. Longmans & Co.  
 BURT..... (1918). The Thelephoraceae of North America. Ann Mo. Bot. Gard. 5, pp. 301-372.  
 (1919). Ibid. in Ann. Mo. Bot. Gard. 6, pp. 253-280.  
 (1920). Ibid. in Ann. Mo. Bot. Gard. 7, pp. 81-248.  
 (1925). Ibid. in Ann. Mo. Bot. Gard. 12, pp. 213-257.  
 (1926). Ibid. in Ann. Mo. Bot. Gard. 13, pp. 173-354.  
 COKER..... (1920). Journ. Elisha Mitchell. Soc. 35, pp. 113-182, Pl. 55, Fig. 1.  
 CONRAD & MAUBLANC (1924-1933). Icones Selectae Fungorum 3, Pl. 220, ii.  
 CORNER..... (1932 a). Annals of Bot. 46, pp. 71-111.  
 (1932 b). Trans Brit. Myc. Soc. 17, pp. 51-81.  
 (1947). New Phytologist 46, p. 195.  
 (1948 a). New Phytologist 47, p. 22.  
 (1948 b). Trans. Brit. Myc. Soc. 31, pp. 234-245.  
 COUCH..... (1938). The genus *Septobasidium*. Univ. of North Carolina Press.  
 CUNNINGHAM..... (1946). N.Z. Journ. Sci. & Technology 28, pp. 238-251.  
 (1947-1950). N.Z., D.S.I.R. Plant Diseases Div., Bulletins Nos. 72-83.  
 DE BARY..... (1887). (English Translation). Comparative morphology and Biology of the Fungi, Mycetozoa and Bacteria. Oxford.  
 DERX..... (1948). Bull. Bot. Gard. Buitenzorg. ser. iii, 17, p. 468.  
 DONK..... (1931). Revise van de Nederlandse Heterobasidiomycetae en Homobasidio-mycetae Aphyllophoraceae. Deel 1. Wageningen.  
 (1933). Revision der Niederländischen Homobasidiomycetae-Aphyllophoraceae. Deel ii. Amsterdam-Haarlem.  
 FINDLAY..... (1951). Trans. Brit. Myc. Soc. 34, p. 146.  
 GÄUMANN..... (1922 a). Ann. Mycol. 20, pp. 257-271.  
 (1922 b). Ann. Mycol. 20, pp. 272-289.  
 (Transl. Dodge, 1928). Comparative morphology of Fungi. McGraw Hill.  
 GREGOR..... (1932). Ann. Mycol. 30, p. 464.  
 GROVE..... (1913). The British Rust Fungi, p. 14, Fig. 16. C.U.P.  
 HEIM..... (1936). Rev. de Mycologie 1, pp. 223-256.  
 (1948). Rev. de Mycologie Suppl. Colonial 13, pp. 1-12.  
 (1949). Rev. de Mycologie Suppl. Colonial 14, pp. 1-14.  
 HÖHNEL & LITSCHAUER (1907). K. Akad. Wiss. Wein. Sitzungs. 116.  
 INGOLD..... (1940). Trans. Brit. Myc. Soc. 24, pp. 30-31, Figs. 1-2.



- JUEL..... (1897). Bih. Svenska Vet.-Akad. Handl. 23, iii, 12, pp. 1-27.  
 (1898). Jahrb. Wiss. Botanik 32, pp. 361-388.
- KNOLL..... (1912). Jahrb. Wiss. Botanik 50, pp. 453-501.
- LANGERON..... (1945). Précis de Mycologie. Paris.
- LEVINE..... (1913). Bull. Torrey Bot. Club 40, pp. 137-181.
- LINDER..... (1940). Mycologia 32, pp. 419-447.
- Lloyd..... (1923). Mycological Notes 7, p. 1232.
- LOHWAG..... (1947). Ann. Mycol. 35, pp. 157-193.  
 (1940). Ann. Mycol. 38, pp. 401-450.
- LOWE..... (1942). Polyporaceae of the New York State. N.Y. State College of Forestry, Tech. Publ. No. 60.
- MALENCON..... (1939). Bull. Soc. Myc. de Fr. 55, pp. 42-52, Figs. 3, 4.
- MAIRE..... (1902). Recherches cytologiques & taxonomiques sur les Basidiomycetes. Bull. Soc. Myc. de Fr. 18.
- MARTIN..... (1934). Mycologia 26, p. 264.  
 (1935). Bull. Torrey Bot. Club. 62, pp. 339-343, Fig. 2.  
 (1936). Mycologia 28, p. 215, Fig. 1, 9.  
 (1938). Amer. Journ. Bot. 25, pp. 682-685.  
 (1939). Mycologia 31, pp. 507-518.  
 (1945). Mycologia 37, p. 540.  
 (1948). Lloydia 11, pp. 111-122.
- MASSEE..... (1887). Journ. Roy. Microsc. Soc. pp. 205-208.
- MCGUIRE..... (1941). Lloydia 4, p. 16, Pl. 2, Figs. 18, 19.
- NANNFELDT..... (1947). Svensk Botanisk Tidskrift 41, p. 332.
- NEUHOFF..... (1924). Botan. Archiv. 8, pp. 250-297.
- NYLAND..... (1949). Mycologia 41, p. 688.
- OLIVE..... (1950). Mycologia 42, p. 389, Fig. 2, 17, 20, 21.
- OVERHOLTS..... (1929). Proc. Internat. Congress Plant Sci. 1926, Ithaca, 2, pp. 1688-1712.
- PATOUILLARD..... (1894). Bull. Soc. Myc. de Fr. 10, pp. 77-78.  
 (1899). Bull. Soc. Myc. de Fr. 15, pp. 199-200.  
 (1900). Essai taxonomique sur les familles et les genres des Hymenomycetes. Lons-le-Saunier.
- PETCH..... (1915). Ann. Roy. Bot. Gard. Perad. 6, pp. 43-68, Pls. 2-7.
- PILÁT..... (1926). Ann. Mycol. 24, pp. 201-230.
- ROGERS..... (1932). Bot Gazette 94, pp. 86-105.  
 (1933). Ann. Mycol. 31, pp. 181-203.  
 (1934). Univ. of Iowa Stud. in Nat. Hist. 16, pp. 160-183.  
 (1935). Univ. of Iowa Stud. in Nat. Hist. 17, pp. 3-43.  
 (1936). Mycologia 28, pp. 347-362.  
 (1943). Farlowia 1, p. 115.  
 (1944). Mycologia 36, pp. 70-103.  
 (1947). Mycologia 39, pp. 556-564.
- ROGERS & JACKSON.... (1943). Farlowia 1, pp. 263-336.
- SHEAR & DODGE..... (1925). Journ. Agric. Res. 30, pp. 407-417.
- SINGER..... (1945). Lloydia 8, pp. 170-230, Pl. 3, Fig. 9.  
 (1947). Farlowia 3, pp. 155-157.
- TALBOT..... (1952). Trans. Brit. Myc. Soc. 35, pp. 123-128.
- THOMPSON..... (1936). Mycologia 28, p. 223, Figs. 1-13.
- TULASNE..... (1853). Ann. Sci. Nat. ser. iii, 19, p. 196.
- VAN TIEGHEM..... (1893). Jour. de Bot. (Morot) 7, p. 77 et. seq.
- WAKEFIELD..... (1911). Trans. Brit. Myc. Soc. 3, p. 280.  
 (1913). Trans. Brit. Myc. Soc. 4, pp. 113-120, Pl. 3, Fig. 3-5.  
 (1935). Differential characters in some resupinate Hymenomycetes (Manuscript). Summary in Proc. 6th Internat. Bot. Congr. (Amsterdam). Leiden, 1935.
- WAKEFIELD & PEARSON (1920). Trans. Brit. Myc. Soc. 6, pp. 319-320.
- WAKEFIELD & PEARSON (1923). Trans. Brit. Myc. Soc. 8, p. 218, Fig. 4.
- WHELDEN..... (1934). Mycologia 26, pp. 415-435.  
 (1935 a). Mycologia 27, pp. 41-57.  
 (1935 b). Mycologia 27, pp. 503-520.  
 (1935 c). Rhodora 37, p. 121.  
 (1936). Amer. Journ. Bot. 23, p. 544.



# A Note on Sterigmata in General.\*

By

M. A. Donk.†

The sterigmata in *Tulasnella* and *Gloeotulasnella* develop in three phases. First, they grow out into the swollen, spore-shaped bodies which have attracted so much attention. Secondly, after these voluminous bodies have reached their maximal size and gone through an outwardly stationary period (nuclear division in certain species), they emit an outgrowth, rather conical and short in *Tulasnella* and rather finger-shaped and longer in *Gloeotulasnella*. Finally these outgrowths produce apically pointed tips on which are formed the basidiospores to be shot away at maturity. I propose to call the successive portions protosterigma, secondary protosterigma, and spiculum <sup>(1)</sup> respectively.

The formation of a secondary protosterigma is not of common occurrence among hymenomycetes. Except in *Tulasnella* (where they may be indistinct) and *Gloeotulasnella* it is encountered in many gelatinous Heterobasidiae, like Tremellaceae, for instance in *Tremella* Fr. and *Exidia* Fr. <sup>(2)</sup>. In these instances the basidia are deeply embedded in a gelatinous matrix. They send out towards the surface (primary) protosterigmata, starting as globular buds which elongate into hypha-like threads and, after having stopped growth just below the surface of the fruit-body, become more or less clavate in their upper portion. Much of the protoplasmatic contents of the basidium-cells accumulates here. Next this clavate and rounded apical portion emits a more slender outgrowth, the secondary protosterigma, which, as it reaches beyond the surface, produces the spiculum and the basidiospore. It would appear that the differentiation into a primary and secondary protosterigma is largely due to a temporary interruption of the growth of the sterigma. This may be interpreted as a rest-period, but it is more likely to be one of internal activity preparatory to the quick formation of the spiculum and ballistospore at such a great distance from the basidial body which usually plays the important rôle in the process of violent discharge of the spore. More often the protosterigma develops without interruption until it has formed its spore and no secondary protosterigma is discernible.

The definition of a protosterigma should perhaps be: that part of the sterigma which bears the spiculum, or, in terms of development: a sterigma before it has formed the spiculum. (The full-grown sterigma might be termed a metasterigma.) This makes the protosterigma an outgrowth of the basidium, which, either very soon when it is still a minute, more or less rounded bud, or after growing out characteristically and considerably, forms the spiculum; it also makes the protosterigma a universal feature of those basidiomycetes that discharge their spores forcibly. It may be assumed that even the delicate sterigma starts as a nipple- to knob-like protuberance that rapidly produces the spiculum.

\* This note originally formed part of a manuscript dealing with what I would call the tulasnelloid fungi. These are, for instance, characterised by their basidiospores exhibiting repetition.

† Keeper of Herbarium Bogoriense, Kebun Raya Indonesia. Published with permission of the Director of Kebun Raya Indonesia.

<sup>(1)</sup> The term "spiculum" is taken from L. R. Tulasne (in Ann. Sci. nat., Bot. iii 19: 196, 1853) who interchanged it with "sterigma". It is here restricted, in accord with its etymology, to the pointed tip of a sterigma upon which the violently discharged spore is produced.

<sup>(2)</sup> Compare G. W. Martin in Mycologia 37: 534, 1945. For figures, see for instance, Brefeld (Unters. Gesamtgeb. Mykol. 7: pls. 5-7) and G. W. Martin (in Univ. Iowa Stud. nat. Hist. 18 (3): f. 17, 1944.



That the protosterigma is often not noticed would be accounted for by the facts (i) that its formation and the subsequent production of the spiculum take such a short time that the intermediate stages are only exceptionally seen, and (ii) that the smaller sterigmata when full-grown do not show any appreciable outer differentiation into protosterigma and spiculum. This lack of differentiation at maturity is typical of all horn-shaped (outward curved and slender-conical) sterigmata, but yet I have been able to find the bud-like protosterigma in many cases and in modern literature it is even now and then depicted. Among the heterobasidious fungi it is usually considerably developed, often up to hypha-like or slender-clavate; in *Ceratobasidium* and in certain species of *Botryobasidium* it is finger-shaped and usually somewhat ventricosely swollen at the time that the sterigma starts producing the spore; in *Tulasnella* it is a voluminous, ovoid body before it grows out further.

Protosterigmata, when they are well developed, are now often called epibasidia, and simultaneously the term sterigma is restricted to the spiculum. Since I can neither accept a term that covers besides protosterigmata (*Tulasnella*, *Tremella*) also metabasidia (*Auricularia*), nor a terminology that does not homologize the sterigmata of *Tremella* with those of *Auricularia*, I have abandoned such a confusing term as epibasidia altogether<sup>(3)</sup>. For those appendages of the metabasidia called epibasidia by Neuhoff and Rogers the new term protosterigmata might appear a convenient substitute, but it should not be forgotten that less well developed protosterigmata occur throughout the hymenomycetes. "Epibasidia" may be very small and practically totally reduced even in Tremellales; compare, for instance *Sebacina obscura* G. W. Mart<sup>(4)</sup>.

Not all hymenomycetes exhibit violent spore discharge. There are a few genera that produce sticky spores which become freed by hydrolysis (slime spores) or by breaking off by mechanical disturbance from outside (dry spores)<sup>(5)</sup>. Examples of the first are *Hoehnelomyces* Weese (Auriculariaceae-Phleogenoideae) and *Sirobasidium* Lagerh. & Pat. and *Hyaloria* A. Möll (Tremellaceae); of the second *Phleogena* Link. (Auriculariaceae-Phleogenoideae) and *Xenolachne* D. P. Rogers (Tremellaceae). Basidia that do not forcibly discharge their spores have been called apobasidia by D. P. Rogers<sup>(6)</sup>; if such a term is needed at all, one is forced to provide also for a companion term for basidia that do (ballistobasidia).

Spores that are not forcibly discharged may be either sessile (*Phleogena*, *Hoehnelomyces*, *Sirobasidium*) or borne on sterigmata (*Hyaloria*, *Xenolachne*). In the latter case the sterigmata lack the spiculum (which evidently plays an important rôle in the process of ballistospore discharge) and the whole of them would appear comparable to the protosterigma, a term which thus becomes superfluous here.

<sup>(3)</sup> Donk in Meded. Nederl. Mycol. Ver. 18-20: 78-81. 3 fs. 1931.

<sup>(4)</sup> G. W. Martin in Lloydia 7: 70. f. 5. 1944.

<sup>(5)</sup> Mason, Annot. Account Fungi recd, List ii, Fasc. 3: 77, 1937.

<sup>(6)</sup> In Mycologia 39: 558, 1947. It should be recalled that the term apobasidium was originally coined by Vuillemin (Champignons 349, 1912) for a much more inclusive notion.

## The Genus *Stereum* in South Africa.

By

P. H. B. Talbot.

A preliminary examination of the many collections of *Stereum* in the National Herbarium, Pretoria, suggested that these were greatly in need of revision. The result of this work has been that of sixty-seven recorded names in *Stereum* only twenty-two are accepted here as good species for South Africa.

The task of untangling the South African records has been considerably lightened by Dr. E. M. Doidge's check lists of species and pertinent literature (in *Bothalia* 5, 1950). This immensely valuable book, being largely a compilation, is inevitably a record of wrong identifications as well as correct ones; but its value is that it is a faithful and virtually complete record. The reader is referred to Doidge's lists for literature relating to the species of the genus *Stereum* in South Africa. In much of the cited literature, the species are merely listed without description or illustration, but there are papers by van der Byl, Lloyd, and Wakefield, which treat of taxonomy and form the basis of our knowledge of this genus. Insofar as they affect South African species, Lloyd's comments are seldom very clear or disciplined.

In general the literature citations in this paper are limited to the original place of publication of a species or record, and a reference to Doidge's check lists (*Bothalia* 5, 1950). Any attempt to include full references to foreign descriptions of each species would have been thwarted by the absence here of much of the important literature. For the same reason the synonymy of each species is not given in full but is generally limited to species of which type or authentic material (denoted by an exclamation mark after the name of the species) has been seen by the writer.

Specimens are cited by number only, except for establishing synonyms. Unless otherwise denoted, these numbers refer to collections in the National Herbarium, Pretoria. A fuller citation may be traced by following up these numbers in Doidge's check lists.

In sorting out the herbarium material into taxonomic species before naming them, it was considered that minor variations in colour, size or hairyness were relatively unimportant. Habit and general appearance of the plants, linked with characteristic microscopic features, were the chief guide in grouping specimens into taxonomic species. Microscopic characters were stressed since in a group of species of the same habit they provide reliable constant differences. This treatment has possibly resulted in a certain amount of merging together of species, e.g. in the merging of *S. kalchbrenneri* with *S. hirsutum*. It was felt that this was desirable if not carried to extremes.

The materials used in this study were all dried herbarium specimens, unless otherwise stated. The mountant employed in microscopic work was 5 per cent potassium hydroxide solution with the addition of 1 per cent aqueous phloxine as stain. Measurements given for "thickness in section" exclude the hairy zone of the abhymenial surface. Such measurements were made on sections mounted as above, but not squashed out. For a clear view of the microscopic organs it is generally necessary to squash the sections gently under the cover glass.

The records of *Stereum* for South Africa are arranged in alphabetical order of the specific epithets. Synonyms and doubtful or excluded species are printed in italics; accepted species are printed in bold face. A key to the accepted species is given at the end of the paper.

For the loan of specimens, the author is much indebted to the following institutions: Herbarium Royal Botanic Gardens, Kew; Herbarium, Paris Natural History Museum; Herbarium, British Museum (Natural History); Herbarium, South African Museum; Mycological Herbarium, Department of Agriculture, Southern Rhodesia. Special thanks are due to Dr. R. W. G. Dennis for his kindness in comparing several specimens with material in Kew Herbarium.

*Deur die goedgunstigheid van die trustees van die Herbarium P. A. van der Byl, en van die Stellenbosse Universiteitsraad, is 'n geleentheid vir die bestudering van wyle Prof. van der Byl se versamelings van Stereum soorte aangebied. Verwysing na hierdie monsters sal in verband met die verskillende soorte gevind word.*

**Stereum** Persoon ex S. F. Gray, A Natural Arrangement of British Plants 1 (1821) 652; Persoon in Roemer Neues Mag. Bot. 1 (1794) 110, Obs. Myc. 1 (1796) 35.

Fructifications coriaceous, membranous or subligneous, stipitate, sessile, effuso-reflexed or resupinate, or dimidiate, or infundibuliform, simple or branched. Stem lateral or central or absent. Hymenium inferior, smooth, sometimes rugose or exceptionally tubercular. Flesh pale, the context usually having an intermediate layer of more or less horizontally arranged hyphae. Spores hyaline, smooth. Cystidia, gloeocystidia or vesicles present or absent. Setae absent. Annual or perennial, lignicolous or terrestrial.

The genus *Stereum* Pers. ex S. F. Gray is accepted as validly published without conservation and is typified by the species *S. hirsutum* (Willd.) Pers. ex S. F. Gray. Reasons for the selection of this species as the type are given by Rogers (in Farlowia 3, 1949, pp. 450 & 480) and by Donk (in Bull. Bot. Gard. Buitenzorg ser. iii, 18, 1949, pp. 98-99).

(1) *Stereum adnatum* Lloyd (!) Myc. Notes 7 (1925) 1336, Fig. 3093; Doidge loc. cit. p. 487.

= *Stereum rimosum* Berk. var. *africanum* Talbot (!), for reasons given in Bothalia 6 (1951) 39.

(2) *Stereum affine* Lév. in Ann. Sci. Nat. ser. iii, 2 (1844) 210; Saccardo Syll. Fung. 6 (1888) 559; Doidge loc. cit. p. 487.

#### FIG. 6.

Pileus thin, coriaceous, lignicolous, solitary or gregarious, stipitate, arising from a circular light-buff coloured mycelial pad 3-6 mm. in diam., the pad sometimes being common to more than one pileus and the pilei in this case sometimes uniting above. Pileus usually flabellate, rarely infundibuliform and then sometimes split down one side, radius 1-3 cm. (rarely up to 7 cm.) from attachment, width 0.5-2 cm. Large specimens may be deeply divided into a number of flabellate pileoli with a common cuneate base, but this condition is rare. Surface smooth, yellow-brown to bay or chestnut, with a "shot" lustre in a radial direction, not colour-zoned, sparsely pruinose with scanty hairs, glabrescent. Hymenium light buff, pinky buff or light red-brown when old, smooth. Margin concolorous or somewhat paler on the abhymenial surface, thin, undulate or with small incisions, often reflexed in infundibuliform specimens. Stipe 1-2.5 mm. in diam., 0.5-2 cm. long, light buff colour, minutely velutinate. Thickness in section 560-800  $\mu$ .

Basidia:  $3.2-4 \times 23-27 \mu$ , subcylindrical, compact.

Spores: abundant,  $3.2 \times 4 \mu$ , hyaline, subglobose, ovate or broad elliptical, smooth, frequently uniguttulate.

Gloeocystidia:  $(8)-9.6-12.8 \times 50-70-(100) \mu$ , hyaline, with homogeneous, contents, subulate or fusoid or irregularly cylindrical, rounded at apex, base attenuated, found in the hymenium and arising from subhymenial hyphae, abundant.



Hyphae: Skeletal hyphae 3·2–4  $\mu$  wide, hyaline, thick-walled, not septate, unbranched, without clamps; Generative hyphae hyaline, 2·4–3·2  $\mu$  wide, thin-walled, septate, scantily branched, with rare clamp connections.

Tissue differentiation: A faint, narrow, yellowish zone subtends the abhymenial surface from which the scanty hairs arise.

Abhymenial hairs: 9·6–12·8  $\times$  50–180  $\mu$ , hyaline, scanty, solitary, thick-walled with wide lumen, septate or non-septate, simple or occasionally forking.

Specimens examined: 28310, 36716, 30880, 15555, 27774, 27335, 27336, 31653, 9206, 28911, 11628, 12048, 36799, 32474, 34227, 34952, 36869, 14909 (a): Universiteit van Stellenbosch, Herbarium P. A. van der Byl Nos. 145, 694, 514 (as *S. glabrescens*).

Several South African specimens filed under *Stereum glabrescens* B. & C. prove to be *S. affine*. Burt (in Ann. Mo. Bot. Gard. 7, 1920, 110) states that *S. glabrescens* lacks gloeocystidia, which are present in all the South African specimens which the writer has seen in this group. Wakefield (in Det. Kong. Norske. Vidensk. Selsk. Forh. 9, 1936, 52) suggested that the specimens referred to *S. glabrescens* by van der Byl (in Trans. Roy. Soc. S. Afr. 10, 1922, 151, Fig. 1 and in Ann. Univ. Stellenbosch 7, 1929, 37) were probably *S. affine*. The writer has examined v.d. Byl's material and confirms that it is *S. affine*, showing quite obvious gloeocystidia when stained with phloxine.

Apart from gloeocystidia, it is suggested that another difference between these two species is that *S. glabrescens* is always flabelliform while *S. affine* may sometimes be infundibuliform.

(3) *Stereum albo-badium* (Schw. ex Fr.) Fries: Recorded by Kalchbrenner in Grev. 10 (1881) 58; Doidge loc. cit. p. 491.

The material referred to by Kalchbrenner as "*Stereum albo-badium* Fr. Ep. 551 C.B. Spec. (sic.), in mont. Boschberg", was seen at Kew with the sheet annotated thus: "*Stereum albo-badium* Schwein. Afr. austral. Type of Kalchbrenner, Com. MacOwan 9/83".

This specimen lacks cystidia and branched paraphyses and cannot be *S. albobadium*. The material is so scanty that it probably cannot be named with certainty.

*S. albobadium* is a North American species of characteristic appearance. It is resupinate with a free margin. The hymenium is umber-bay in colour, and velvety. The margin is narrow and whitish. Microscopically it has brownish branched paraphyses and small encrusted cystidia. Ravenel material (not type) was seen at Kew.

(4) *Stereum amoenum* Kalchbr. & MacOwan (!) in Grev. 10 (1881) 58; Theumen in Flora 59 (1876) 424; Doidge in loc. cit. p. 490 (Nec. *S. amoenum* Lév.).

This species was described from South Africa. As this name was preoccupied, Saccardo redescribed the species under the name *Stereum kalchbrenneri* Sacc. (in Sacc. Syll. Fung. 6, 1888, 568). *S. amoenum* is thus an obligate synonym of *S. kalchbrenneri*. Lloyd (Myc. Notes 4, 1915, L. 60, 10, Note 341) notes these name changes under *S. kalchbrenneri*.

The writer has examined authentic material of *S. amoenum* in Herb. Macowanianum Nos. 1084 & 1086 sub Herb. S.A. Museum No. 34269 as *S. kalchbrenneri*. On the herbarium sheet, van der Byl has noted that *S. kalchbrenneri* is very close to *S. hirsutum* and differs virtually only in having a more luxuriant fructification and darker hairs on the upper surface than is usual in *S. hirsutum*. He added that they could scarcely be considered as separate species.

The writer's impression of *S. kalchbrenneri*, gained from examining MacOwan's specimens, is that this species is characterised by a combination of luxuriant growth, rather dark brown hairs, a reddish hymenium and a tendency to develop cystidioid hyphae. The hymenial colour varies between pinkish buff, cinnamon, mikado brown and russet (Ridgway Pls. xxix & xv) while the colours seen on the abhymenial surface are warm buff, clay colour, dark sudan brown (Ridgway Pls. xv, xxix, iii) and whitish.

In the National Herbarium, Pretoria, the specimens showing the best agreement with MacOwan's material of *S. kalchbrenneri* are Nos. 31454, 11255 and 13793. However, it is quite impossible to separate this species from *S. hirsutum* owing to the considerable variation and intergrading seen in the specimens assigned to each. This is illustrated by comments on the herbarium sheets such as "pallid form of *S. kalchbrenneri*" and "dark form of *S. hirsutum*". Since no constant difference can be demonstrated between the two, it is thought best to refer *S. amoenum* and *S. kalchbrenneri* to *Stereum hirsutum* (Willd.) Pers. ex S. F. Gray.

It may be noted here that Bresadola (in Ann. Myc. 14, 1916, 232) cites *S. amoenum* Kalchbr. & MacOwan and *S. vellereum* Berk. as synonyms of *S. friesii* Lév. The writer doubts whether this can be substantiated.

(5) *Stereum atrocinereum* (Masse) van der Byl in Ann. Univ. Stellenbosch 7 (1929) 44; Doidge loc. cit. p. 493.

*Peniophora atrocinerea* Masse (!) in Journ. Linn. Soc. Bot. 25 (1889) 141.

As noted by Doidge, this is a synonym of *Stereum schomburgkii* Berk. (!). Reasons for this conclusion were given by the writer in Bothalia 6 (1951) 44.

The material of Herb. MacOwanianum No. 1197 sub Herb. S.A. Museum No. 34284, on which van der Byl based his description of *S. atrocinereum*, is undoubtedly part of the type number of *Peniophora atrocinerea*, which the writer has also seen in Kew Herbarium. The part in Herb. S.A. Museum shows spores which are hyaline, cylindrical-depressed or broad elliptical,  $3.4 \times 6.8 \mu$ .

As previously recorded, MacOwan's material is a pale form of *S. schomburgkii*, which in turn is now found to be synonymous with *Stereum fulvum* (Lév.) Sacc. *Stereum atrocinereum* is accordingly referred to *Stereum fulvum* (Lév.) Sacc. (see p. 315).

(6) *Stereum australe* Lloyd (!) in Lloyd Myc. Notes 4 (1913) L. 48, 10, Note 115; Ibid. 4(1915) L. 60, 15, Note 387; Ibid. 5(1917) L. 65, 2; Doidge loc. cit. p. 487.

*Stereum tenebrosum* Lloyd (!) *nomen nudum* in Lloyd Myc. Notes 5(1918) L. 67, 16, Note 692; Doidge loc. cit. p. 493.

As "*Stereum lobatum* with cinereous hymenium", Lloyd in Lloyd Myc. Note 4(1913) L. 46, 3.

As "*Stereum lobatum* (Kunze) Fr. var. *cinereum* Lloyd", Doidge loc. cit. p. 487.

*Stereum transvaalium* v.d. Byl (!) in Ann. Univ. Stellenbosch 7(1929) 41; Doidge loc. cit. p. 494.

### Fig. 13

Pileus tough, coriaceous, lignicolous, solitary or more often gregarious, often laterally connate, occasionally imbricate, flabellate or cuneate, attached by a reduced base, or reflexed and attached by a long narrowly-effused base, or occasionally orbicular and sessile attached by a central umbo; 2.5-4 cm. radius  $\times$  3-5-(10) cm. wide. Surface concentrically furrowed and zoned with velutinate hairs of reddish-brown to light yellow-brown to greyish colour, becoming worn off and smooth in the ridges when old and weathered. Hymenium reddish-brown when moist becoming cinereous to cinereous-buff on drying, smooth, reflecting the abhymenial furrows, "bleeding" red when fresh and bruised. Thickness in section 640-1000  $\mu$ .

Basidia: compact, hyaline, clavate,  $4.4-8 \times 30 \mu$ .

Spores: uncertain. Possibly  $2.5 \times 5.6 \mu$ , hyaline, smooth, elliptical, with one side depressed. ( $3 \times 4 \mu$  fide van der Byl;  $4 \times 6 \mu$  fide Lloyd).

Conductors: originating as modified skeletal hyphae in the trama and subhymenium, curving into but not beyond the hymenium, thick-walled, non-septate, contents brownish, walls hyaline, lumen often widening towards the apex,  $4.8\text{--}6.4\ \mu$  diam.

Hyphae: Skeletal hyphae thick-walled, non-septate, unbranched, hyaline or sometimes dilutely coloured,  $6.4\ \mu$  diam.; Generative hyphae rather thin-walled, hyaline, septate, without clamps,  $3.2\ \mu$  diam. The two hyphal types are intertwined throughout the trama.

Tissue differentiation: Tissue hyaline above a horizontal yellow-brown zone which subtends the abhymenial hairs.

Abhymenial hairs: hyaline, thick-walled ( $3.2\text{--}4.8\text{--}6.4\ \mu$  diam., fasciculate).

Specimens examined: 27519, 27520, 31033, 30890, 27522, 28490, 15557, 26390, 31816, 28966, 27611, 27721, 15559 (2 specimens), 30269, 30270, 28848, 31852, 40218 (T.R.L. 202), 40219 (T.R.L. 69), 40220 (T.R.L. 2); 8847, 1464 (as *S. tenebrosum* det. Lloyd); Universiteit van Stellenbosch, Herbarium P. A. van der Byl No. 1472 (Type of *S. transvaalium*).

In Lloyd's writing cited above, there is a slight ambiguity in Letter 48, but the writer takes this letter to mean that Lloyd recognised *S. australe* and *S. tenebrosum* as the same species, i.e. that they are both the same as his "*S. lobatum* with cinereous hymenium" mentioned in Letter 46. This opinion is confirmed by examination of specimens in Herb. Pretoriae which were determined by Lloyd variously as *S. australe* and *S. tenebrosum* and which the writer is confident represent only one species.

*S. australe* is well characterised by its smallish brown, velutinate pilei, the cinereous hymenium (when dry) and the presence of conductors. Old specimens may weather greyish with bare chestnut zones and then resemble *S. fasciatum* externally.

Regarding the inclusion of *Stereum transvaalium* as a synonym of *S. australe*, see notes given under the former species on p. 328.

(7) *Stereum bellum* (Kunze) Saccardo, Syll. Fung. 6(1888) 563; Doidge loc. cit. p. 488.

*Thelephora bellum* Kunze in Flora (1830) 370.

Fig. 8

Pilei small, dimidiate, sessile, laterally connate, imbricate, lignicolous, about 1 cm. radius from attachment and attenuated towards the base thus somewhat cuneate in single specimens, rigid, tough and not flexible. Surface reddy-brown, often concentrically zoned and with a relatively wide light tan coloured margin, rather sparsely velutinate. Hymenium smooth, yellow-orange colour. Thickness in section  $720\text{--}1200\ \mu$ .

Basidia: (immature) cylindrical,  $20 \times 3.2\ \mu$ .

Spores: few seen, hyaline, ovate or subglobose,  $2 \times 2.5\ \mu$ .

Gloeocystidia: quite numerous in the hymenium, hyaline, thinwalled, deep-staining, pyriform to fusoid or ventricose,  $7.5\text{--}12 \times (12)\text{--}15\text{--}25\text{--}(40)\ \mu$ .

Cystidia: rare (see comment below), hyaline, thickwalled, apically encrusted or smooth ( $6.5\text{--}10\text{--}12 \times 30\text{--}37\ \mu$ ; in the hymenium, fusoid to conical).

Hyphae: all hyaline and closely intertexted; skeletal hyphae non-staining, non-septate, very seldom branching, thick-walled with a narrow or occasionally fairly wide lumen,  $3.2\text{--}4.8\ \mu$  wide; generative hyphae thin-walled, deep-staining, tortuous, with clamps, branched,  $2.4\text{--}3.2\ \mu$  wide.

Tissue differentiation: tissues uniformly composed of closely intertexted hyphae without a notably differentiated abhymenial zone.

Abhymenial hairs: hyaline to pale straw colour, thickwalled with narrow lumen, usually widening somewhat towards the apex; apex rounded or sometimes pointed; hairs usually with 2–4 septa,  $3.5\text{--}8\ \mu$  wide and projecting  $80\text{--}104\ \mu$  from the surface.



Specimens examined: Universiteit van Stellenbosch, Herbarium P. A. van der Byl No. 645.

In the absence of other material for comparison there is some doubt whether this specimen is correctly named, but it is thought best to record this under van der Byl's determination as *Stereum bellum*. The specimen shows several features which suggest an affinity with *Stereum involutum*, yet is sufficiently different in detail to be held apart. It is noted by Lloyd (Syn. Stip. Stereum, 1913, 41) that *S. bellum* sensu Bresadola non Kunze is *Stereum bresadoleanum*, a species synonymous with *S. involutum*. See also under *S. friesii* (p. 314).

The cystidia described above were clearly seen in only one section made from this specimen and may be merely a thickened and encrusted form of the gloeocystidia. Gloeocystidia were seen in all sections. As far as habit is concerned, this specimen might be taken casually for a small and immature *S. hirsutum*, but its reddish velutinate surface is different, and the microscopic structure quite different. Saccardo (loc. cit.) mentioned that *S. bellum* has an affinity with *S. hirsutum*.

(8) *Stereum bicolor* (Pers. ex Fr.) Fries, Epicrisis (1838) 549, Hym. Eur. (1874) 640; Doidge loc. cit. p. 488; Talbot in Bothalia 6 (1951) 39.

*Thelephora bicolor* Persoon, Syn. Meth. Fung. (1801) 568, Myc. Eur. 1 (1822) 122; Fries, Syst. Myc. 1 (1821) 438.

*Stereum laxum* Lloyd (!) in Lloyd Myc. Notes 4 (1915) L. 60, 10, Note 339; Doidge loc. cit. p. 491.

*Stereum fuscum* (Schrad.) Quelet, Flor. Myc. de Fr. (1888) 14.

*Stereum coffeatum* Berk. & Curt. (!) in Grev. 1 (1873) 164.

*Stereum pannosum* Cooke (!) in Grev. 8 (1879) 56.

#### FIG. 21.

Occasionally entirely resupinate, usually resupinate-reflexed, sometimes pileate, imbricate, soft, spongy texture. Abhymenial surface snuff-brown, concentrically furrowed, floccose, becoming smooth; margin paler. Hymenium smooth, whitish to creamy, not furrowed, sometimes rimose when dry, rather velvety. In section up to 1000  $\mu$  thick; hymenial layer hyaline, circa 100  $\mu$  thick, the remaining tissues coloured brownish. Not adnate.

Basidia: 3.5–5.5  $\times$  22–27  $\mu$ , cylindrical, with 2–4 sterigmata.

Spores: hyaline, smooth, elliptical, unilaterally depressed, or oblong, frequently uniguttulate, 3.4–5  $\times$  2–3  $\mu$ .

Gloeocystidia: very abundant in the hymenium, not usually emergent, hyaline, very refractile, thinwalled, cylindrical, fusoid or somewhat ventricose, about 4–11  $\times$  90  $\mu$ , borne on very narrow hyaline hyphae about 2  $\mu$  wide, contents homogeneous when young but appearing to solidify and become fragmented when old and then resembling cystidia or mineral concretions.

Hyphae: all smooth, thin-walled, with occasional to numerous clamp connections, much branched, septate; Subhymenial hyphae colourless or pale brownish; Tramal hyphae brown, 3–6  $\mu$  wide, loosely intertexted.

Tissue differentiation: There is no dark compact zone subtending the abhymenial surface; that surface is floccose and composed of ordinary brown hyphae.

Specimens examined: 27596, 28964 (T.R.L. 200), 35422, 30891, 27784, 28555, 27766, 31728, 31851, 30698; van der Byl (2239) in Kew; MacOwan (1244) C.B.S. in Kew; MacOwan (1244) as *Thelephora biennis* Fr. sub *Stereum fuscum* in Herb. S.A. Museum No. 34292.

The type number of *Stereum laxum* Lloyd, 31321, *A. V. Duthie* (56), on decaying leaves and twigs, Stellenbosch, agrees in every respect with *S. bicolor* and is accordingly reduced to synonymy. Lloyd (loc. cit.) wrote that *S. laxum* has no cystidia, but its gloeocystidia are quite obvious. His suggestion that *S. laxum* resembles an *Hypochnus* in context, is also rather misleading.

*S. bicolor* has also appeared in South African literature (and elsewhere) under the name *S. fuscum* (Schrad.) Quel., but the latter is nomenclaturally unacceptable (see Talbot, loc. cit.). Doidge (loc. cit. p. 488) lists records of *S. bicolor* which were improperly placed by other authors under *Thelephora biennis*.

(9) *Stereum bresadoleanum* Lloyd (!), Syn. Stip. Stereum in Lloyd Myc. Notes 4 (1913) 41; Doidge loc. cit. p. 488.

= *Stereum involutum* (Klotzsch) Fries; see p. 317.

(10) *Stereum caperatum* Lloyd (!) in Lloyd Myc. Notes 4 (1916) 549, Fig. 751. [non *S. caperatum* (Berk. & Mont.) Massee]; Doidge loc. cit. p. 494.

As this name was a later homonym of *S. caperatum* (Berk. & Mont.) Massee, Lloyd subsequently changed to it *Stereum turgidum* Lloyd (!), (Lloyd in Myc. Notes 5, 1916, L. 63, 15, Note 502). For reasons given in Bothalia 6 (1954), p. 339, the latter species is regarded as synonymous with *Stereum cinerascens* (Schw.) Massee (!). See also the following description.

(11) *Stereum cinerascens* (Schw.) Massee (!) in Journ. Linn. Soc. Bot. 27 (1890) 179; Doidge loc. cit. p. 488; Talbot in Bothalia 6 (1951) 40 and Ibid. 6 (1954), p. 339.

*Thelephora cinerascens* Schwein. in Amer. Phil. Soc. Trans. n.s. 4 (1832) 167.

*Stereum turgidum* Lloyd (!) in Lloyd Myc. Notes 5 (1916) L. 63, 15, Note 502; Stevenson & Cash in Bull. Lloyd Library 35 (1936) 58; Doidge loc. cit. p. 494.

*Stereum caperatum* Lloyd (!) in Lloyd Myc. Notes 4 (1916) 549, Fig. 751 [non *S. caperatum* (Berk. & Mont.) Massee].

*Lopharia mirabilis* (B. & Br.) Patouillard in Bull. Soc. Myc. de Fr. 11 (1895) 14, Pl. 1; Doidge loc. cit. p. 501; Talbot in Bothalia 6 (1951) 56 and Ibid. 6 (1954), p. 339.

*Radulum mirabile* Berk. & Br. (!) in Journ. Linn. Soc. Bot. 14 (1873) 61.

*Lopharia lirellosa* Kalchbr. & MacOwan (!) in Grev. 10 (1881) 58.

#### FIG. 18.

Fructifications coriaceous, resupinate, effused with a narrow reflexed margin, or effuso-reflexed; not adnate. Abhyemial surface (when exposed) ochraceous, ashen or warm buff, tomentose, obscurely zoned or concentrically furrowed. Hymenium first smooth and whitish, later creamy-ochraceous or pinkish buff. Hymenial variations include smooth or slightly scabrid states, papillate or tubercular developments, or strongly developed warts or teeth or incised ridges arranged irregularly or in somewhat concentric patterns and sometimes forming incomplete shallow pores. Thickness in section, excluding ridges or teeth, 250–800  $\mu$ .

Basidia: 40–65–(80)  $\times$  (5)–9–11  $\mu$ , clavate, with 4 sterigmata.

Spores: hyaline, smooth, oblong-cylindric or oblong-elliptical, often with one side depressed, 5.5–14.3  $\times$  4.4–8.8  $\mu$  (usually 10.6–11.8  $\times$  6.1  $\mu$ ).

Cystidia: embedded or projecting, heavily encrusted with large crystals, thick-walled, often faintly coloured at the base, conical or subfusiform, apex blunt or pointed, 50–150  $\times$  12–24  $\mu$ . They may be emergent up to 50  $\mu$  or embedded in stages throughout the trama.

Hyphae: 3–5  $\mu$  diam., hyaline or faintly coloured, rather opaque and thick-walled, those next to the substratum forming a denser, coloured layer.

Abhymenial hairs: adpressed or suberect, coloured, 3·5–5  $\mu$  diam.

Specimens examined: As *S. cinerascens* 28688, 28498, 28926, 34377, 35421, 35309, 33077, 33213, van der Byl (2732); As *S. turgidum* Lloyd & *S. caperatum* Lloyd, type number 31332 (A. V. Duthie, 74); As *Lopharia lirellosa*, type, P. MacOwan, C. Bon. Spei, in Herb. Kew; As *Lopharia mirabilis*, type, Thwaites 328, Peradeniya, Ceylon, 1868, in Herb. Kew; 27797, 28302, 27799, 31309, 31356, 31911, 27769, 28697, 31397, 28299, 34553, 36786, 33205, 36785, van der Byl (2261, 2620, 551, 1429); as *Radulum lirellosa*, 31309; as *Radulum* sp., 27556.

An extensive comparison of this species with *Lopharia mirabilis* and *Stereum turgidum*, leading to the sinking of the genus *Lopharia*, is given by the writer in Bothalia 6 (1954), p. 339. There, the variability of this fungus is discussed and reasons are given for associating under one name, *S. cinerascens*, what at first sight appear to be totally disrelated forms, some with smooth hymenia and some with highly convoluted hymenia apparently characteristic of the Hydnaceae. That these form the extremes of a graded series with identical microscopic characters, is only realised when a large number of collections have been seen and carefully studied.

(12) *Stereum cinereum* Lév.; recorded by van der Byl in Trans. Roy. Soc. S. Afr. 10 (1922) 153, f. 4; listed as doubtful by Doidge loc. cit. p. 488.

The collection cited by van der Byl as the basis of this record is apparently not to be found in any herbarium. This species is omitted from van der Byl's later summary of the South African Thelephoraceae (in Ann. Univ. Stellenbosch 7, 1929) as though he were doubtful of the determination.

(13) *Stereum concolor* (Jungh.) Sacc., Syll. Fung. 6 (1888) 561; Doidge loc. cit. p. 491.

Lloyd recorded some of van der Byl's collections under this name; for references see Doidge loc. cit. Doidge lists this species doubtfully as a synonym of *Stereum lobatum* (Kunze ex Fr.) Fr. Van der Byl omits reference to *S. concolor* in his writings, and the specimen in his herbarium No. 807 which was determined by Lloyd as *S. concolor* has been annotated by van der Byl as a "young condition of *S. lobatum*". The writer has seen this specimen and taken alone it could well be referred to *Stereum concolor*, for this species is distinctive enough in typical specimens to warrant a name of its own. However, there is little doubt that *S. concolor* is in fact only a young stage of *S. lobatum*. This is confirmed by the finding of collections, part of which could be confidently referred to *S. concolor* and part to *S. lobatum*, e.g. No. 11291 in the National Herbarium. The principal differences between these growth forms are in their colour and hairiness.

Forms classed as *S. concolor* have a uniform, even, velvety brown tomentum on the surface, ranging in colour from light yellow-brown to a somewhat deeper brown spaced wide apart in concentric zones. The impression is a continuous tomentum of a rather light brown colour. In forms classed as *Stereum lobatum* the tomentum is frequently interrupted by bare or glabrescent zones and the colour zonation includes brownish, greyish or greeny-grey, and narrow hazel or chestnut stripes. There are no apparent microscopic differences between these forms.

In view of the above, *S. concolor* is treated here as a synonym of *Stereum lobatum* (Kunze ex Fr.) Fr.



(14) *Stereum cyphelloides* Berk. & Curt. in Journ. Linn. Soc. Bot. 10 (1868) 331; Saccardo, Syll. Fung. 6 (1888) 558; Burt in Ann. Mo. Bot. Gard. 7 (1920) 112; Martin Lloydia 7 (1944) 76.

FIG. 5.

Fructifications soft, terrestrial, flabellate, attached by a reduced base which is vaguely continued into a faint mycelial pad, laterally substipitate; radius 4–8 mm. from the attachment, width 5–9 mm. Stem flattened, 1.5–3 mm. wide. Surface radially striate with appressed fibrils which anastomose towards the base, lacking a cuticle, the context hyphae merely running out into the surface fibrils; colour light creamy-yellow all over. Hymenium concolorous, smooth. Margin not noteworthy. Thickness in section 580–750  $\mu$ .

Basidia: compact, hyaline, cylindrical,  $3.2 \times 29 \mu$ .

Spores: smooth, hyaline, typically pip-shaped with an attenuated apiculus,  $2.4-3.2 \times 5.6-7.2 \mu$ .

Hyphae: all of one kind, hyaline, thin-walled, branched, septate, without clamps,  $2.4-3.2 \mu$  wide.

Tissue differentiation: No bordering zone beneath the abhymenial surface. Texture soft and absorbent, the tissues fairly compact but easily teased apart into individual hyphae.

Specimens examined: 31419; 11528 (sub *Thelephora*).

The species is distinctive for its small whitish pilei, the soft texture and the peculiar pip-shaped spores. In No. 31419 all the spores seen were pip-shaped, but in No. 11528 many of them exhibited the "curiously angled and distorted" character described and figured by Martin loc. cit. The writer is indebted to Dr. R. W. G. Dennis for comparing No. 31419 with type material in Kew Herbarium.

The literature references given by Doidge loc. cit. p. 488, for this species, are incorrect, but the writer has not been able to trace the correct reference.

(15) *Stereum diaphanum* (Schw.) Cooke ex Saccardo in Syll. Fung. 6 (1888) 558; Doidge loc. cit. p. 488.

*Thelephora diaphana* Schweinitz apud Berk. & Curt. in Acad. Nat. Sci. Philad. Journ. 2 (1853) 278 (fide Burt in Ann. Mo. Bot. Gard. 7, 1920, 98).

FIG. 4.

Fructifications coriaceous to fibrous and brittle when dry, terrestrial, growing on humus and buried wood, centrally stipitate, deeply infundibuliform, usually single, occasionally two pilei fusing above. Pileus (0.4)–2.5 cm. diam., (0.3)–1.8 cm. radius from attachment; surface creamy to pale yellowish, silky-fibrillose, radially linear-striate, sometimes showing one or two obscure concentric colour zones of a slightly darker yellow-brown. Hymenium smooth, creamy, cracking radially when dry and revealing a silky-fibrillose trama; margin sometimes entire, more often undulating and shortly lacinate or splitting down the radius into lobes, very thin, sometimes involute. Stipe 1–2 mm. wide  $\times$  7–10 mm. long, light creamy colour, clothed with short, fine hairs especially near the base, where there is usually a small mycelial pad. Thickness in section 480–800  $\mu$ .

Basidia: cylindric-clavate, about  $35 \times 3.2-4.8 \mu$ .

Spores:  $3.2-4 \times 6.4-8 \mu$ , elliptic-oblong with one side depressed and the end attenuated into a lateral apiculus, hyaline, smooth, abundant.

Gloeocystidia:  $8-9.6-(16) \times 58-86 \mu$ , subcylindric or clavate, hyaline, smooth, thinwalled, with homogeneous contents, immersed in the hymenial layer or often projecting up to  $32-48 \mu$  beyond it.

Hyphae: hyaline, branched, septate, with thin, firm walls,  $3.2-6.4 \mu$  wide, lacking clamps but with occasional H-anastomoses, all of one type.

Tissue differentiation: there are no abhymenial hairs and no compact tissue differentiated just below the abhymenial surface.

Specimens examined: 21099, 21208, 23160, 14516, 20403, 31858: Universiteit van Stellenbosch, Herbarium P. A. van der Byl No. 662 (as *S. pusillum* Berk.).

The pilei of this species have a well-marked tendency to split radially down the striae. They are brittle, and creamy in colour, when dry. Our description differs from that of Burt (loc. cit.) in spore size and thickness of the pilei. Burt has referred to the "hairlike cystidia", which are here called gloeocystidia. Although these may be emergent, their smooth walls and homogeneous, readily stained contents suggest gloeocystidia. These organs are similar to those found in *Corticium praetermissum* (= *Peniophora tenuis*) and it is somewhat a matter of personal taste what they shall be called.

This species is known so far from the Fountains-Groenkloof valleys near Pretoria, where it is fairly common, and from Durban, where one collection has been made.

The writer is indebted to Dr. R. W. G. Dennis for comparing Nos. 21099, 21208, with Schweinitz material in Kew Herbarium. Spores were lacking in the last-mentioned, but otherwise there was very close agreement.

(16) *Stereum durbanense* van der Byl (!) in Trans. Roy. Soc. S. Afr. 10 (1922) 155, Fig. 8, in Ann. Univ. Stellenbosch 7 (1929) 45; Doidge loc. cit. p. 489.

*Stereum tomentosum* van der Byl (!) in Trans. Roy. Soc. S. Afr. 10 (1922) 156, Fig. 9, in Ann. Univ. Stellenbosch 7 (1929) 45; Doidge loc. cit. p. 493.

#### FIG. 12.

Fructifications corky, drying tough, brittle and woody, lignicolous, somewhat orbicular, attached by the centre and partly resupinate over wide areas then widely reflexed, pilei sometimes connate and occasionally imbricate over the main pileus, overall size up to  $7 \times 12$  cm. Surface with a thick pad-like tomentum of closely matted hairs, ochraceous to cinnamon, becoming greyish, if rubbed showing bright cinnamon-ochre colour, concentrically furrowed with more or less glabrous areas in the furrows and hence somewhat colour-zoned, colour lighter near the margin. Hymenium light-brown to light-fawn colour, smooth or slightly rimose or convoluted in places into small tubercles or larger humps, reflecting the abhymenial furrows near the margin, cracking a little on drying. Margin acute, undulate or lobed, usually a little darker than the rest of the hymenium. Thickness in section excluding tomentum  $950-1500 \mu$ , the tomentum itself  $1000-2000 \mu$  thick.

Basidia: hyaline, cylindric-clavate, forming a dense palisade,  $3.2 \times 17-26 \mu$ .

Spores: hyaline, smooth, oblong-cylindric with a small lateral apiculus,  $3.2 \times 4.8-6.4 \mu$  ( $3.4 \mu$  diam. fide van der Byl).

Hyphae: of two kinds. Skeletal hyphae unbranched,  $5.6-8 \mu$  wide, dilutely to darkly coloured, thick-walled, with narrow or wider lumen, showing septa in the wider parts of the lumen and with contents darker brown than the walls. Generative hyphae  $3.4-4 \mu$  wide, branched, clearly septate, subhyaline to hyaline, thin-walled with wide lumen.

Tissue differentiation: hyphae compact and very closely interwoven; a dark zone subtends the abhymenial surface.

Abhymenial hairs: very thick and closely matted, dark red-brown, thick-walled,  $4.8-8 \mu$  wide.

Specimens examined: 15613 (three specimens ex Natal Herb. 471, originally determined by Lloyd as *S. subpileatum* Berk. and changed by van der Byl to *S. durbanense* van der Byl); 31852 (N.H. 606); 31898 (N.H. 692); 35559 (W. G. Rump, 756); 32007 (N.H. 904); 32478 (N.H. 341) as *Stereum tomentosum* van der Byl; 15601 (N.H. 341)

as *Stereum* sp.; Universiteit van Stellenbosch, Herbarium P. A. van der Byl No. 293 (Type of *S. durbanense*), 294, 517; Herbarium P. A. van der Byl No. 305, 132 (as *S. tomentosum*).

Careful microscopic examination of material of *Stereum tomentosum* has failed to distinguish it from *Stereum durbanense*, while it is believed that the minor macroscopic differences (in colour of the surface and the hymenium) are of no specific significance. They may have been more apparent in the fresh material but are now hardly distinguishable in the dry specimens. Since *S. durbanense* has page priority in the original place of publication of these two species, *S. tomentosum* is relegated to synonymy. Incidentally the latter is a more suitable epithet, especially as the species is not limited to the vicinity of Durban.

Authentic material of *S. durbanense* was found in the National Herbarium under No. 15613 (Natal Herb. 471) split up into three separate packets. This material had been determined by Lloyd as *Stereum subpileatum* Berk. (Lloyd Myc. Notes 5, 1917, L. 66, 15, Note 634; listed by Doidge loc. cit. p. 489). In assigning some of van der Byl's collections to this species, Lloyd noted that they differed from *S. subpileatum* in the absence of cystidia. Thus van der Byl (1922, loc. cit.) described the new species *S. durbanense* to accommodate them, and later (van der Byl, 1929, loc. cit.) noted that *S. durbanense* possessed a few hairlike cystidia, but that these were not encrusted as in *S. subpileatum*. The writer has seen material of *S. subpileatum* in Kew Herbarium, and there were bottle-brush paraphyses as well as cystidia. It is quite certain that *S. durbanense* is different, and that *S. subpileatum* must be excluded from South African lists.

The writer was unable to find in any of the material of *S. durbanense* the cystidia which van der Byl described as "20-60  $\times$  6-4  $\mu$ , emergent up to 8  $\mu$ , hairlike, colourless, not encrusted, very few found, only in parts of the hymenium". There were, however, scanty cystidioid hyphae which intruded into the hymenium but not beyond it. These were smooth, almost colourless, thick-walled, cylindrical, about 4.8  $\times$  48  $\mu$ , and were probably a form of skeletal hypha.

The absence of conductors differentiates *S. durbanense* from *S. rimosum*, *S. rimosum* var. *africanum*, and *S. rugosum*, with which it might be confused. Small specimens, though uncommon, might be confused with thick forms of *Stereum australe*, but for the absence of conductors. The species is quite distinctive and the microscopic check for conductors is seldom necessary. A further characteristic is that *S. durbanense* has a rather narrow hyaline hymenium above a brownish context, when viewed with the naked eye.

(17) *Stereum duriusculum* Berk. & Br. (!) in Journ. Linn. Soc. Bot. 14 (1873) 66; Doidge loc. cit. p. 489.

#### FIG. 22.

In Bothalia 6 (1951) 51-53, the writer described and discussed this species, and related ones, and proposed the new combination *Asterostromella duriuscula* (B. & Br.) Talbot. It is clear that *Stereum* is an unsatisfactory genus for the reception of this species, while many people will no doubt think the same of *Asterostromella*. What is needed is a study of the genera *Dichostereum* Pilat and *Vararia* Karsten, where possibly the true affinities of *Stereum duriusculum* will lie. For the present this species is left as *Asterostromella duriuscula*, and the reader is referred to the above paper for a description. For convenience the species is keyed out with other *Stereum* species in this paper.

(18) *Stereum elegans* Mey.; recorded by Kalchbrenner in Grev. 10 (1881) 58; Saccardo Syll. Fung. 6 (1888) 553; Doidge loc. cit. p. 493.

Kalchbrenner's record of this species referred to MacOwan's collection No. 1232. Doidge loc. cit., notes this material under *S. thozetii* Berk., which was the determination



given it by van der Byl on the sheet in Herb. S.A. Museum No. 34266. Having studied MacOwan's material, and had cospecific material checked at Kew, the writer confirms its determination as *Stereum thozetii* Berk.

Another collection, J. M. Wood No. 396 (National Herbarium Pretoria No. 10653) is filed in Pretoria and at Kew under *Stereum nitidulum*. This collection was cited by Bottomley (in S.A. Journ. Sci. 13, 1916, 440) as "*Stereum elegans* = *Stereum nitidulum* B.", and the sheet at Kew is annotated "= *Stereum elegans*", by Bresadola. This material certainly does not correspond with Petch's description of *S. elegans* (in Ann. Roy. Bot. Gard. Perad. 9, 1924, 260). The writer enlisted the aid of Dr. R. W. G. Dennis in comparing this specimen with material of *S. elegans* at Kew and was informed that it was a good match with *S. nitidulum* but not with *S. elegans*. It is dealt with in this paper under *S. nitidulum*.

It would appear that *Stereum elegans* must be excluded at present from South African lists.

(19) *Stereum fasciatum* (Schw.) Fr., Epicr. Syst. Myc. (1838) 546; Doidge loc. cit. p. 489.

The writer has seen no South African material which he can confidently refer to *S. fasciatum*. Many specimens are so named in the herbaria, particularly in Herbarium P. A. van der Byl. At first, van der Byl (in Trans. Roy. Soc. S. Afr. 10, 1922, 155, Fig. 7) classified his specimens as *Stereum lobatum*. Later (in Ann. Univ. Stellenbosch 7, 1929) he referred them all to *S. fasciatum*, commenting that up till then he had seen no typical specimens of *S. lobatum* in South Africa, although *S. fasciatum* was common in parts.

The writer has examined van der Byl's specimens in the Universiteit van Stellenbosch, Herbarium P. A. van der Byl. Most of them are undoubtedly *Stereum lobatum*; a few are rather small forms which may possibly be called *S. fasciatum*, but there are many intermediate forms and nowhere to draw the line between the two extremes. Furthermore these small forms are not altogether like North American specimens of *S. fasciatum*. Still other specimens labelled *S. fasciatum* have proved on examination to be *Stereum australe*.

In Bothalia 6 (1951) 45 and 50 the writer cited a collection of J. M. Wood No. 163 (under *Stereum luteobadium*) as *Stereum fasciatum*. This was an error, and re-examination of that collection has failed to distinguish it from *S. lobatum*.

It is felt that *Stereum fasciatum* must be listed as a doubtful species for South Africa. Notes differentiating *S. fasciatum* and *S. lobatum* are given under the latter species (p. 319).

(20) *Stereum friesii* Léveillé. Zoll. Verz. p. 17; Saccardo, Syll. Fung. 6 (1888) 266; Doidge loc. cit. p. 489.

#### FIG. 9.

Pileus sessile, lignicolous, slightly effused, not flexible, semi-dimidiolate or broadly spatulate, 1-3 cm.  $\times$  1-1.5 cm., sometimes laterally connate. Surface velutinate or with a somewhat thicker tomentum, concentrically zoned, brown and light yellow-brown. Margin light brown, broad in young specimens, narrower in old. Hymenium creamy to cinnamon-cream, shading off near the attachment to a bay colour with a smoky violet tint. Margin wide and creamy in colour on the hymenial side. Sections 700-1000  $\mu$  thick.

Basidia: small, cylindrical, 12-16  $\times$  2.5-3.2  $\mu$ .

Spores: quite abundant, hyaline, smooth, ovate to subglobose, (1.7)-2.4  $\times$  3.2  $\mu$  or about 2.5-3  $\mu$  diam.

Cystidia: in the hymenium, projecting 11-18  $\mu$ , or embedded, hyaline, fusoid with fairly thin walls and wide lumen; walls minutely rugose and encrusted, easily losing the encrustation and then smooth, 27-38  $\times$  10-12  $\mu$ .

Gloeocystidia: smooth, thin-walled, deep-staining, embedded, fusoid,  $7.5-8 \times 12-30 \mu$ .

Hyphae: skeletal hyphae  $3.3-4.8 \mu$  wide, hyaline, smooth, unbranched, without septa, thick-walled with a narrow lumen, the lumen occasionally wider; generative hyphae thin-walled, deep-staining, much branched, with occasional clamps, somewhat tortuous,  $2.4-3.2 \mu$  diam.

Tissue differentiation: all tissues are rather compact and densely interwoven. There is no denser, coloured zone differentiated below the surface.

Abhymenial hairs: rather scanty, hyaline, thick-walled at the base with a wide lumen, the walls narrowing and the lumen widening towards the apex;  $6.4 \mu$  diameter.

Specimens examined: Universiteit van Stellenbosch, Herbarium P. A. van der Byl No. 378.

This specimen is undoubtedly one of the same species as van der Byl No. 645 as *Stereum bellum*. It is not yet known whether *S. bellum* or *S. friesii* is applicable to the species, if either name is.

(21) *Stereum fulvum* (Lév.) Sacc., in Saccardo Syll. Fung. 6 (1888) 570; Doidge loc. cit. p. 489.

*Thelephora* (*Stereum*) *fulva* Leveille (!) in Ann. Sci. Nat. ser. iii, 5 (1846) 149.

*Stereum schomburgkii* Berkeley (!) in Journ. Linn. Soc. Bot. 13 (1873) 168; Saccardo, Syll. Fung. 6 (1888) 568; Doidge loc. cit. p. 493; Talbot in Bothalia 6 (1951) 43.

*Stereum atrocinerum* (Masse) van der Byl in Ann. Univ. Stellenbosch 7 (1929) 44.

*Peniophora atrocinerea* Masse (!) in Journ. Linn. Soc. Bot. 25 (1889) 141.

*Stereum retirugum* Cooke (!) in Proc. Roy. Soc. Edinb. (1882) 456; Saccardo Syll. Fung. 23 (1925) 510; Doidge loc. cit. p. 492.

*Hymenochaete olivaceum* Cooke (!) in Grevillea 14 (1885) 11.

## FIG. 20.

Resupinate or resupinate-reflexed, or conchiform and attached by a small umbo, orbicular-confluent, thin, coriaceous or papyraceous, loosely attached to the substratum. Reflexed surface tomentose, glabrescent when old, buffy-brown, concentrically furrowed in pileate specimens, the troughs being paler. Hymenium smooth, or more usually furrowed concentrically and cracking radially; colour very variable, through umber, brown, olive brown, light yellow-brown, brownish slate, depending on the state of development. Margin narrow, yellowish, finely fibrillose, usually free. Context colourless, 200–(500)  $\mu$  thick in section.

Basidia: clavate,  $4.5-6 \times 20-25 \mu$ , in young stages in a regular palisade, later interrupted and exceeded by the setoid hyphae.

Spores:  $3.2 \times 6.4-6.8 \mu$ , hyaline, broad elliptical or cylindrical-depressed, smooth.

Setoid hyphae:  $3.5-8 \mu$  wide, cylindrical, often with a fusoid apex, brown, minutely rugulose near the apex, thick-walled with a very narrow lumen which sometimes expands at the apex, immersed or emergent up to  $16 \mu$ , originating as skeletal hyphae which curve upwards into the hymenium, total length variable and indeterminate, very densely arranged, darkening in alkali.

Hyphae: skeletal hyphae brown, thick-walled, smooth, without clamps, of the same dimensions as the setoid hyphae; generative hyphae hyaline to light yellow-brown intermeshing with the skeletal,  $3.5-4.5 \mu$  diam., often indistinct, thin to thicker-walled, with occasional clamp connections.

Tissue differentiation: The hyphae form a more or less horizontal web without a darker or more compact basal layer.

Abhymenial hairs: pallid to light yellow-brown, 5  $\mu$  diam., fairly thick-walled, septate, with occasional clamp connections.

Specimens examined: Type of *Thelephora (Stereum) fulva* Lév., Drège 9441, Cap-de-Bonne-Esperance, in Herb. Mus. Paris; Type of *Stereum schomburgkii*, Schomburg, Australia, in Herb. Kew.; Type of *Peniophora atrocineria* Masee (sub "*Corticium atrocinerium* Kalchbr."). *P. MacOwan*, Cape Province, in Herb. Kew.; as *Stereum atrocinerium* (Masee) van der Byl, MacOwan 1197 (Herb. S. Afr. Mus. No. 34284); as *Stereum membranaceum*, A. Pegler (1234) in National Herbarium Nos. 8414 and 34454; 31863, 8756, 35237, 28942, 20944, 27644, 27544, 27552, 28496, 28499, 28304, 28504, 28687, 34951, 36800, 36801, 11968, 11770, 28565, 27758, 27607, 28493, 30881, 33074, 33565, 34454, 8414, 2301, 33990, 33179; Höeg F. 67 in Herb. Kew.

This species is well known under the name *Stereum schomburgkii*. Recent examination of the type of *S. fulvum* Lév., borrowed from Herb. Mus. Paris, has shown that the two are synonymous, and consequently the earlier epithet must now be taken into use.

In Bothalia 6 (1951) 44, the writer gave reasons for reducing *S. atrocinerium* (Masee) van der Byl to synonymy, and also reasons for the variation in colour of the specimens. The material which van der Byl described as *S. atrocinerium* has now been seen, in Herb. S. Afr. Mus. 34284. It corresponds with the material of *Peniophora atrocineria* in Herb. Kew, and is almost certainly part of the same collection.

Doidge's record of *Stereum retirugum* refers to Mocambique only, but it is confirmed that Cooke's type of the species in Herb. Kew is synonymous with *S. fulvum*.

The only record of *S. membranaceum* Fr. for South Africa (Pole Evans and Bottomley in Ann. Bolus Herb. 2, 1918, 192) is based on a pale form of *S. fulvum* and not on the species suggested. Lloyd (in Lloyd Myc. Notes 6, 1920, 960) suggests that *S. schomburgkii* differs mainly from *S. membranaceum* in having an amber hymenium instead of one which is violaceous but fades when old. Actually *S. membranaceum* is a synonym of *Stereum papyrinum*, a species not unlike *Stereum umbrinum*.

The type number of *Stereum fulvum*, Drège No. 9441, is cited in mistake for Drège No. 9442 under *Stereum murrayi*, by Doidge loc. cit. p. 491.

(22) *Stereum fuscum* (Schrad.) Quélet, Flor. Myc. de Fr. (1888) 14; Doidge loc. cit. p. 488.

Doidge lists the South African records of this species and correctly indicates that it is a synonym of *Stereum bicolor* (Pers. ex Fr.) Fr.

MacOwan's specimen No. 1244 (as *Thelephora biennis*, Herb. S. Afr. Mus. 34292), determined by van der Byl as *S. fuscum*, is *S. bicolor*. A note on the nomenclature of this species was given in Bothalia 6 (1951) 40.

(23) *Stereum glabrescens* Berk. & Curt.; Recorded by van der Byl in Trans. Roy. Soc. S. Afr. 10 (1922) 151, Fig. 1, and in Ann. Univ. Stellenbosch 7 (1929) 37; Doidge loc. cit. p. 487.

A wrong record based on specimens of *Stereum affine* (see p. 305). *Stereum glabrescens* is not known to occur in South Africa.

(24) *Stereum hirsutum* (Willd.) Pers. ex S. F. Gray, A Natural Arrangement of British Plants 1 (1821) 652; Persoon in Roemer Neues Mag. Bot. 1 (1794) 110; Saccardo Syll. Fung. 6 (1888) 563; Doidge loc. cit. p. 489.

*Thelephora hirsuta* Willdenow, Flor. Berol. Prod. (1787) 397; Fries, Syst. Myc. 1 (1821) 439; Persoon, Syn. Meth. Fung. (1801) 570, Myc. Eur. 1 (1822) 116.

*Stereum amoenum* Kalchbr. & MacOwan (!) in Grev. 10 (1881) 58; Doidge loc. cit. p. 490 (nec *S. amoenum* Lév.).



*Stereum kalchbrenneri* Saccardo, Syll. Fung. 6 (1888) 568; Doidge loc. cit. p. 490.

FIG. 11.

Fructifications coriaceous, lignicolous, gregarious, usually laterally connate, imbricate, effuso-reflexed or dimidiate, occasionally semi-resupinate and attached by an umbo; radius 1–4 cm. from attachment, 0.7–5 cm. wide or several centimetres wide by lateral confluence. Surface covered with strigose-fasciculate or matted hairs, showing concentric zonation, concentrically furrowed, coloured greyish, light yellow-brown, or a deeper reddish-brown. Hymenium smooth, creamy to buff, cinnamon or light orange colour. Margin thin, entire to undulate or lobed, not notably differentiated. Thickness in section 600–800  $\mu$ .

Basidia: cylindric-clavate, 25–35  $\times$  3.5–4.8  $\mu$ .

Spores: hyaline, cylindrical, sometimes slightly bent, smooth, 2.4  $\times$  6.4–8  $\mu$ .

Hyphae: generative hyphae hyaline, smooth, thin-walled with wide lumen, septate, branching, lacking clamps, 2.4–3.2–(4)  $\mu$  wide; skeletal hyphae hyaline, smooth, thick-walled with narrow lumen, occasionally septate, unbranched, without clamps, 6.4–8  $\mu$  wide.

Cystidioid hyphae: present in many but not all specimens, arising as skeletal hyphae and curving into the hymenium but not beyond it, hyaline, thick-walled with a narrow lumen except at the apex where the lumen expands, contents of lumen hyaline to yellow-brown, up to 9.6–(16)  $\mu$  wide at apex.

Tissue differentiation: A compact golden coloured dense zone subtends the abhymenial surface; the trama is composed of closely intertwined hyphae arranged more or less horizontally.

Abhymenial hairs: 6.4–9.6  $\mu$  diam., hyaline or rarely dilutely coloured, smooth, thick-walled with narrow lumen, occasionally septate, intertwined and matted or arranged somewhat parallelly.

Specimens examined: 34953, 23374, 27517, 24822, 11292, 11255, 34956, 31525, 24873, 31298, 34955, 11290, 34479, 34957, 34954, 12173, 31709, 17299, 9060, 31234, 23670, 11290, 30516, 27722, 30720, 30261, 30803, 9148, 27539, 24822, 1952, 8776, 8773, 2344, 27518, 34072, 30735, 27538, 33067, 26697, 17803, 18151, 20586, 23671, 17101, 27518, 11255, 30948, 31454, 13793, 31737, 28967, 28880, 27647, 27340, 25879, 15484, 2344 (in part), 23474, 22085, 18146, 30893, 36707, 34200, 31031, 1017, 11292, 23374, 29719, 13073, 33067, 28859, 28835, 28756, 17788, 15496, 28951, 30719, 31298, 31807, 31892, 32504; Sub. *S. spadiceum*, 13793, 12993, 5651, 1707.

Reasons for sinking *S. amoenum* and *S. kalchbrenneri* in synonymy are given in the notes on those species.

Compared with European specimens of *S. hirsutum*, the majority of South African material is more luxuriant, not so generally greyish in surface colour, and very frequently shows a strong development of cystidioid hyphae. These are features which contributed to the erection of the species *S. kalchbrenneri*, but the species is so variable and merges so closely into more typical *S. hirsutum* that it is felt that a separate name is not warranted. See also notes on *S. vellereum*, p. 329.

(25) "*Stereum hirsutum* forma *kalchbrenneri*". In *S. Afr. Journ. Sci.* 42 (1946) 133, Simpson & Talbot listed a collection under the name "*Stereum hirsutum* (Willd.) Fr. *kalchbrenneri* forma", under the impression that *S. kalchbrenneri* had already been proposed as a form of *S. hirsutum*. It is possible that this citation constituted the proposal of a *nomen nudum* for a new form. The material referred to may be included in the species *S. kalchbrenneri* which we here regard as a synonym of *Stereum hirsutum* (Willd.) Pers. ex S. F. Gray.

(26) *Stereum involutum* (Klotzsch) Fries, *Epicrisis* (1836–38) 546; Saccardo, Syll. Fung. 6 (1888) 560; Lloyd, Syn. Stip. *Stereum*, in Lloyd Myc. Notes 4 (1913) 40; Doidge loc. cit. p. 490.

*Thelephora involuta* Klotzsch (!) in Linnaea 7, p. 499.

*Lloydella involuta* (Kl.) Bresadola in Ann. Myc. 18 (1920) 60.

*Stereum bresadoleanum* Lloyd (!), Syn. Stip. Stereum in Lloyd Myc. Notes 4 (1913) 41; Stevenson & Cash in Bull. Lloyd Library 35 (1936) 51; Doidge loc. cit. p. 488.

*Stereum proximum* Lloyd, Syn. Stip. Stereum in Lloyd Myc. Notes 4 (1913) 40; Doidge in loc. cit. p. 488.

#### FIG. 7.

Fructifications coriaceous, drying tough and with a horny hymenium, lignicolous, gregarious, attached by a reduced base, usually several pilei attached by reduced bases and laterally connate above, semiflabellate or petaloid, radius 1–3 cm. from the attachment, width 1.5–3.5 cm. Surface very finely velutinate, marked with very narrow concentric zones coloured tawny, yellowy-orange, greyish or light brown; not distinctly furrowed, general effect tawny when young becoming darker brown when old. Hymenium waxy, reddish-bay colour, smooth, paler towards the margin, drying darker and distinctly horny. Margin paler on both surfaces, involute or slightly crimped, very thin. Thickness in section up to 1000  $\mu$ .

Basidia: closely packed, rather indistinct, about  $3 \times 16\text{--}20 \mu$ .

Spores: uncertain, thought to be about  $1.6\text{--}2 \times 2.4\text{--}3 \mu$ , elliptical, hyaline.

Cystidia: fusoid, thick-walled, hyaline, staged in the hymenium, embedded, scarcely ever emergent, encrusted at the apex or smooth, encrustation soluble in KOH, always abundant,  $10\text{--}15 \times 27\text{--}66 \mu$ .

Gloeocystidia: usually subulate with a swollen base, sometimes more cylindrical or fusoid, thin-walled, with homogeneous contents, hyaline, embedded in the hymenium and subhymenium, abundant in thicker parts of the specimens seen,  $7.3\text{--}10 \times 40\text{--}66 \mu$ .

Hyphae: generative hyphae thin-walled, hyaline, with occasional septa, branches and clamp connections,  $3.2\text{--}4 \mu$  diam.; skeletal hyphae thick-walled, hyaline, without septa, rarely branched, without clamps,  $3.2\text{--}4.8 \mu$  diam. The two hyphal types are densely intermingled.

Tissue differentiation: There is no well-marked colour zone subtending the abhymenial surface. Unmounted sections show the dark, waxy hymenium and sometimes a similar dark abhymenial zone.

Abhymenial hairs: hyaline to very dilutely coloured, free or fasciculate, thick-walled,  $8\text{--}10\text{--}12 \mu$  diam.

Specimens examined: 14909 b, 31956, 31750, 15556; Type of *Thelephora involuta* Kl., Mauritius, in Herb. Kew.; Universiteit van Stellenbosch, Herbarium P. A. van der Byl Nos. 192, 193 (as *S. proximum*).

Specimens comprising this taxonomic species were found distributed in the National Herbarium under the names *S. proximum*, *S. bresadoleanum* and *S. involutum*, among which was authentic material of *S. bresadoleanum*.

Van der Byl (in Ann. Univ. Stellenbosch 7, 1929, 38) described *S. proximum* and distinguished it from *S. involutum* by the more finely velutinate surface of the former. In the absence of authentic material of *S. proximum*, the writer must follow published synonymy. By Lloyd's own admission (in Lloyd Myc. Notes 7, 1922, 1115, Fig. 2095), *S. proximum* Lloyd is a synonym of *S. bresadoleanum* Lloyd, which he previously suggested (in Syn. Stip. Stereum in Lloyd Myc. Notes 4, 1913, 40) was a form *S. involutum*. Bresadola (in Ann. Myc. 18, 1920, 60) united *S. bresadoleanum* and several other species under the name *Lloydella involuta*, whose specific epithet is accepted here. Having compared type material of *S. involutum*, the writer agrees that *S. bresadoleanum* is synonymous.

The species is characterised by its finely velutinate surface and the waxy, reddish bay hymenium, also by possession of cystidia, gloeocystidia and a dual hyphal system. Gloeocystidia do not appear to be mentioned in available descriptions. They are usually abundant, but might easily be missed without the use of a stain like phloxine.

(27) *Stereum kalchbrenneri* Saccardo (!), Syll. Fung. 6 (1888) 568; Doidge loc. cit. p. 490.

= *Stereum hirsutum* (Willd.) Pers. ex S. F. Gray. See further notes under *Stereum amoenum* (p. 305) and *Stereum hirsutum* (p. 316).

(28) *Stereum laxum* Lloyd (!) in Lloyd Myc. Notes 4 (1915) L. 60, 10, Note 339; Doidge in loc. cit. p. 491.

= *Stereum bicolor* (Pers. ex Fr.) Fr. See p. 308.

(29) *Stereum lobatum* (Kunze ex Fr.) Fries, Epicr. (1838) 547; Saccardo, Syll. Fung. 6 (1888) 568; Doidge loc. cit. p. 491.

*Thelephora lobata* Kunze in Weigelt Exsiccati, 1827; Fries in Linnaea 5 (1830) 527.

#### FIG. 10.

Fructifications coriaceous, sessile, typically wedge- or fan-shaped, tapering to a reduced base which is attached by a small umbo (one centrally attached, infundibuliform specimen was seen), often produced singly, sometimes laterally connate, the connate pileoli produced from one or more umbo. There is very infrequently any resupinate part. Size varying from 4–10 cm. radius  $\times$  2–10–20 cm. in width. Surface concentrically furrowed and colour-zoned, with a thin velvety tomentum of closely matted hairs inclined to rub off easily in old specimens leaving at least some bare zones. Colour of surface uniform light yellow-brown to somewhat deeper brown, reddy brown grey or greeny-gray, especially becoming greyish with hazel or chestnut coloured rubbed zones. Hymenium smooth or reflecting slightly the surface furrows, coloured creamy to light buff, not dark coloured or cinereous. Margin acute, entire or undulate, or vaguely lobate in connate specimens. Thickness in section 700–900  $\mu$ .

Basidia: 3.5–5  $\times$  24–33  $\mu$ , cylindric-clavate, compact.

Spores: 2.7–3.3  $\times$  5.3–(8)  $\mu$ , hyaline, cylindrical with one side a little depressed, or oblong or broad-elliptical, smooth.

Hyphae: hyaline or some very dilutely coloured, unbranched, without clamps. thin-walled, 2.5–4  $\mu$  diam., septate, sometimes with expanded parts up to 8  $\mu$  diam. Other hyphae are thin- to thick-walled with a wide lumen, up to 8  $\mu$  diam. Some of the thick-walled hyphae about 6.4  $\mu$  diam., curve up and intrude into the hymenium.

Tissue differentiation: a yellow-brown zone is present beneath the layer of abhymenial hairs.

Abhymenial hairs: 3.2–6.4  $\mu$  diam., yellowish, thick-walled, septate, somewhat fasciculate.

Specimens examined: 13794, 33379, 31559, 27332, 30741, 28971, 17098, 34950, 34126, 36615, 34210, 34196, 28503, 36613, 11544, 23347, 17811, 9150, 23232, 31560, 27537, 31667, 31296, 30837, 11291, 31559, 11523, 12049, 34516, 14907, 10654 (J. M. Wood, 163), 20972 (MacOwan, 1269); Herb. S.A. Museum 34265 (MacOwan 1163, 1276, as *S. versicolor* then det. van der Byl as *S. fasciatum*).

There is difficulty in separating *S. lobatum*, *S. fasciatum* (Schw.) Fr. and *S. concolor* (Jungh.) Sacc.

The above taxonomic species is composed of specimens which are large and flabellate or slightly lobed, and not effuso-reflexed. They are all rather thin and with a thin, velvety tomentum. Single, typical specimens of *S. concolor* may be held apart from *S. lobatum* on account of their uniform light brown tomentum, but there is little doubt that such forms merely represent a young stage in the growth of *S. lobatum* (see p. 310). The latter is typically greyish or greeny-gray with hazel or chestnut coloured rubbed zones, but specimens with a brownish surface have also been included here under *S. lobatum*.



*Stereum fasciatum* is without doubt very close to *S. lobatum*, but differs principally in being thicker, with a thicker, shaggy tomentum, and in frequently being effuso-reflexed when young, in which state it is strongly reminiscent of *S. hirsutum*. Forms referred to *S. lobatum* are larger, thinner and more flexible and have a finer, softer, adpressed tomentum which rubs off with age leaving the pileus with smooth shining chestnut-brown zones.

There is apparently no distinguishing microscopic character, but it may be convenient to retain the two names for the extreme forms which look very different. Intermediates are to be found, but on the whole *S. fasciatum* is smaller and most frequent in the temperate regions, whereas *S. lobatum* is typically a tropical fungus and sometimes becomes very large.

Some of the differences noted above are based on notes kindly supplied by Miss E. M. Wakefield. Compare also the discussion under *S. fasciatum* (p. 314).

(30) *Stereum lobatum* (Kunze) Fr. var. *cinereum* Lloyd ex Doidge in Bothalia 5 (1950) 487, *nomen nudum*.

Lloyd did not publish the varietal epithet which is attributed to him by Doidge. As Doidge (loc. cit.) noted, this variety is a synonym of *Stereum australe* Lloyd.

(31) *Stereum luteobadium* Fries: recorded by Kalchbrenner in Grev. 10 (1881) 58; Bottomley in S.A. Journ. Sci. 13 (1916) 440.

The collection (Wood 163, National Herbarium 10654, and in Kew Herbarium under *Hymenochaete luteobadia*) cited in the above papers was referred to *Stereum fasciatum* by van der Byl (in Ann. Univ. Stellenbosch 7, 1929, 50) and by Doidge (loc. cit. p. 485), and also by Talbot (in Bothalia 6, 1951, 45 & 50). The writer would now refer it to *Stereum lobatum*. In Herb. Kew there is also a specimen "leg. P. MacOwan, 9/83, C.B.S., Herb. Kalchbrenner" as *S. luteobadium* in the *Hymenochaete luteobadia* folder. This too is *S. lobatum*. *Hymenochaete luteobadia* (Fries) Höhnelt & Litsch. does occur in South Africa.

(32) *Stereum membranaceum* Fr. Recorded by Pole Evans & Bottomley in Ann. Bolus Herb. 2 (1918) 192.

The collection referred to (A. Pegler, 1234, in National Herbarium Nos. 8414 & 34454) is a pale form of *Stereum fulvum* Lev. (!) (see p. 315) with setoid hyphae rather more encrusted than usual. This correction was noted by Doidge loc. cit. p. 493 under *S. schomburgkii*, a synonym of *S. fulvum*.

(33) *Stereum murraili* (Berk & Curt.) Burt in Ann. Mo. Bot. Gard 7 (1920) 131 (as *S. murrayi*); Rogers & Jackson in Farlowia 1 (1943) 290; Doidge loc. cit. p. 491.

*Thelephora murraili* Berk. & Curt. in Journ. Linn. Soc. Bot. 10 (1868) 329.

#### FIG. 16.

Fructifications lignicolous, resupinate, effused, becoming rarely slightly reflexed at the margin, rather tough, woody to corky. Surface hard, crustose, uneven, black, showing as a narrow black seam when resupinate. Hymenium creamy to tan or buff colour, smooth or uneven or somewhat tubercular, becoming shallowly cracked. Margin entire. Thickness in section up to about 5 mm. Context with a veined, mottled or marbled appearance.

Basidia: not seen.

Spores: not seen. (Hyaline, smooth, flattened on one side,  $4.5-5 \times 2.5 \mu$ , fide Burt).

Vesicles: embedded in strata, very numerous, hyaline, with thin firm walls, homogeneous contents, pyriform,  $11-15 \times 12-25 \mu$ . Sometimes the vesicles are elongated, subcylindrical, or ventricose or fusoid thus appearing like gloecystidia and then  $8-14 \times 40-60 \mu$ .

Hyphae: hyaline, suberect, densely interwoven; some are branched, septate, tortuous, submoniliform, deep-staining, up to  $5\ \mu$  diam. Others are straight, much branched, filamentous, not staining,  $1\text{--}2\ \mu$  diam.

Tissue differentiation: The context is divided into strata at the junctions of which the vesicles are most numerous. Much mineral matter is present.

Specimens examined: Universiteit van Stellenbosch, Herbarium P. A. van der Byl No. 708; 39709 (J. Weese, *Eumycetes selecti exsiccati* No. 548).

Van der Byl's collection No. 708 of this species is old and in poor condition. Apart from its greater thickness and the presence of only a few vesicles in good condition, this collection is a good match with *S. murraini*. It is probable that the numerous air spaces which are present in van der Byl's material represent vesicles which have degenerated with age, and the context is not as hard as described for *S. saxitias* Burt (Burt loc. cit. p. 134).

The above description was drawn mainly from European material in the National Herbarium. In it, the elongated form of vesicle was common. As noted by Rogers and Jackson (loc. cit.) this kind of vesicle is encountered in the form of *S. murraini* which was known as *Corticium effusum* Overholts.

(34) *Stereum nitidulum* Berk.; Saccardo Syll. Fung. 6 (1888) 552; Doidge loc. cit. p. 491.

FIG. 2.

Fructifications terrestrial among grass roots, coriaceous, centrally stipitate, infundibuliform, radius  $0.7\text{--}1.2$  cm.,  $0.6\text{--}1.2$  cm. wide. Stipe  $5\text{--}7$  mm. long,  $1$  mm. diam., light tan colour, smooth, glabrous. Surface glabrous, smooth, concentrically zoned with bay and light yellow-brown bands. Margin thin, indented to shortly laciniate. Hymenium light yellow-brown showing one or two darker bands corresponding to the darkest of the bands on the abhymenial surface, i.e. the pileus is semi-translucent. Thickness in section  $500\text{--}800\ \mu$ .

Basidia: cylindrical to clavate,  $20\text{--}30 \times 3\text{--}4.5\ \mu$ , sometimes showing a basal clamp connection.

Spores: hyaline, smooth, ovate, subglobose, or uncommonly broad-elliptical,  $3.2\text{--}4 \times 4.4\text{--}8\ \mu$ , or about  $4.5\ \mu$  diam.

Gloeocystidia: abundant, thin-walled, with homogeneous contents, flexuous, subcylindrical to subfusoid or ventricose, embedded in and just beneath the hymenium,  $40\text{--}80 \times 7\text{--}10.5\ \mu$ .

Hyphae: generative hyphae hyaline, thin-walled, branched, staining deeply, septate, with occasional clamp connections, up to  $3.2\text{--}4.8\ \mu$  diam., but mostly collapsed, intermingled throughout with the skeletal hyphae which are  $3.2\text{--}4.8\ \mu$  wide, hyaline, thick-walled, with lumen narrow or invisible, not staining, unbranched, not septate, without clamps.

Tissue differentiation: There are no abhymenial hairs and no compact zone subtending the abhymenial surface.

Specimens examined: 10653 (J. M. Wood No. 396); Wood A396, Inanda, Natal, in Herb. Kew.

This species is not unlike *S. thozetii* but has spores only about half the size of those of the latter. The sub-translucent character of the pileus is also characteristic, so that the pileus appears brownish on both surfaces. Dr. R. W. G. Dennis kindly compared our material with the type of *S. nitidulum* and found that they were a good match. (See also under *S. elegans*, p. 313).

The material of *S. nitidulum* corresponds very closely with Welwitsch 427, British Museum, as *Stereum ravenelii*, the latter differing only in having gloeocystidia about twice as large and having skeletal hyphae in which the lumen is usually rather wide. The size of the gloeocystidia in these stipitate Stereums is known to vary greatly (cfr.

Martin in Lloydia 7, 1944, 75) but with only a single specimen of each species available for study the limits of variation remain unknown, and for that reason Welwitsch 427 is treated in this paper as *S. ravenelii*.

(35) *Stereum notatum* Berk. & Br.: Recorded by Kalchbrenner in Grev. 10 (1881) 59; Saccardo Syll. Fung. 6 (1888) 581; Doidge loc. cit. p. 491.

The specimens backing this record have been examined. They are J. M. Wood No. 109 (Herb. S.A. Museum No. 34285), and MacOwan No. 1091 in Kew Herbarium, ex Herb. Kalchbrenner.

The description of this species given in Saccardo would apply to practically any young, effuso-reflexed *Stereum*, but according to Petch (in Ann. Roy. Bot. Gard. Perad. 9, 1925, 264) *Stereum notatum*, a Ceylon species, is a "bleeder". There is no indication of conducting vessels or discolouration of the hymenium in either of the two South African specimens under this name. The writer considers that both these specimens are merely young immature, examples of *Stereum hirsutum*, and that *S. notatum* should not appear in South African lists.

(36) *Stereum ochraceo-flavum* Schw. ex Peck; Burt in Ann. Mo. Bot. Gard. 7 (1920) 183.

Doidge (in Bothalia 5, 1950, 491) cites two specimens as the basis of this record for South Africa. One of these, No. 30822, is a pale form of *Stereum hirsutum*. Of the other, No. 22001 (MacOwan, 1091 b), all material is missing except two slides with a few sections on each. The sections do not show the cystidia which Burt (loc. cit.) describes for the species. *S. ochraceo-flavum* is thus considered a very dubious record.

(37) *Stereum ostrea* (Blume & Nees) Fr.; Recorded by Lloyd in Lloyd Myc. Notes 6 (1920) 952; Listed by Doidge loc. cit. p. 489 as a synonym of *S. fasciatum*.

The writer has not seen the specimen cited by Lloyd. Burt (in Ann. Mo. Bot. Gard. 7, 1920, 155) gives *S. ostrea* as a synonym of *S. fasciatum*. Bresadola (in Hedwigia 51, 1912, 321) treats the species *S. lobatum*, *S. concolor* and *S. perlatum* as forms of *Stereum ostrea*. The present writer is not in a position to evaluate the soundness of this treatment.

(38) *Stereum percome* Berk. & Br. (!). Recorded by Doidge loc. cit. p. 491; Massee in Journ. Linn. Soc. Bot. 27 (1890) 185.

Massee's record is based on a specimen in Kew Herbarium under *S. percome*, namely "MacOwan, C.B.S. 9/83". The writer has compared this specimen with the type of *S. percome* and found that MacOwan's specimen is *Hymenochaete nigricans* (Lév.) Bres.

(39) *Stereum perlatum* Berk. in Hook. Lond. Journ. 4 (1842) 153; Doidge loc. cit. p. 492.

The specimen on which this record is based is Universiteit van Stellenbosch, Herbarium P. A. van der Byl No. 144, which Lloyd determined in Lloyd Myc. Notes 6 (1920) 952. It is probably only an old and weathered example of *Stereum lobatum*. It is old, somewhat broken up, and in very poor condition, and should certainly not have been made the basis of a new record for the country, especially considering that *S. perlatum* is only critically separable from *S. lobatum*.

(40) *Stereum proximum* Lloyd, Syn. Stip. Stereum in Lloyd Myc. Notes 4 (1913) 40; Doidge loc. cit. p. 488; van der Byl in Trans. Roy. Soc. S. Afr. 10 (1922) 152, Fig. 2; van der Byl in Ann. Univ. Stellenbosch 7 (1929) 38.

= *Stereum involutum* (Klotzsch) Fries, see p. 317.

(41) *Stereum pruinatum* Berk. & Curt. (!).



The MacOwan collection (1227), Somerset East, in Herb. Kew. has been compared with the type of *S. pruinatum* and is not that species. It is entirely resupinate with a more or less chocolate-coloured hymenium, pruinose under the lens and much cracked on drying. The margin is lighter, yellow-brown, appressed and somewhat fibrillose; texture spongy;  $520\ \mu$  thick. The structure is corticioid. The microscopic characters are not very distinct, the hyphae are dark brown, about  $4\ \mu$  wide, with roughish walls; the walls are thickened but the lumen is quite distinct. The hyphae are branched, without clamps, and of one type only. The basal tissues are more compact and run out into hairs of the same type as the hyphae. It appears to have basidia which are short and dumpy, and gloeocystidia are present. No spores were seen, except some traced to an *Aspergillus* sporophore.

(42) *Thelephora* (*Stereum*) *pulverulenta* Léveillé (!) in Ann. Sci. Nat. ser. iii, 5 (1846) 149; Doidge loc. cit. p. 491.

The type of this species, namely Drège No. 9442, was kindly lent to the author by Herb. Museum Paris. It proves to be undoubtedly a species of *Hymenochaete*, most probably *Hymenochaete luteobadia* (Fr.) Höhnelt & Litsch.

The citation by Doidge (loc. cit. p. 491) of Drège No. 9441 in this connection is an error. Her citation of *S. pulverulentum* Lév. as a synonym of *S. murraili* is no doubt also an error, firstly because Léveillé's species has priority and secondly because Burt (in Ann. Mo. Bot. Gard. 7, 1920, 131) indicates that *S. pulverulentum* Peck is the synonym of *S. murraili*.

(43) *Stereum purpureum* (Pers. ex Fr.) Fries; Persoon in Roemer Mag. Bot. 1 (1794) 110, Obs. Myc. 2 (1799) 92; Fries Epicrasis (1838) 548, Hym. Eur. (1874) 639; Doidge in Bothalia 5 (1950) 492.

*Thelephora purpurea* Persoon, Syn. Fung. (1801) 571, Myc. Eur. 1 (1822) 121; Fries, Syst. Myc. 1 (1821) 440.

*Stereum rugosiusculum* Berk. & Curt. in Grevillea 1 (1873) 162.

#### FIG. 17.

Fructifications coriaceous then later tough, lignicolous, resupinate becoming reflexed, or sessile, dimidiate, single or laterally confluent, often closely imbricate, the pileate part 0.4–1.3 cm. radius and 1–5 cm. wide by lateral fusion. Surface light brown or fawn with matted villose hairs forming a soft thick covering, sometimes with a few obscure colour zones and concentric furrows towards the margin. Margin sometimes concolorous, usually paler or greyish, often involute, sometimes narrowly lobed by fusion of the pilei. Hymenium ceraceous or subgelatinous when fresh, becoming horny on drying, smooth, purplish or violaceous, becoming fawn or brown with a livid tinge when dry.

Basidia:  $25\text{--}40 \times 3\text{--}5\ \mu$ , cylindric to subclavate, with 4 sterigmata, forming a dense palisade.

Spores: usually abundant, hyaline, smooth, elliptical with one side depressed and a small lateral apiculus, or oblong-cylindrical,  $2.5\text{--}3 \times 5.5\text{--}6.5\ \mu$ .

Cystidioles: not always present,  $42\text{--}60 \times 5\text{--}7\ \mu$ , hyaline, not encrusted, smooth, subulate to subcylindrical with a pointed or rounded apex, formed in the hymenium and usually projecting above it.

Vesicles:  $(11)\text{--}17.5\ \mu$  diam. or the same width and up to  $20\text{--}30\ \mu$  long, globular, ovate or pyriform, sometimes elongated especially when near the hymenium, smooth, thin-walled, terminal, with homogeneous contents, formed in a rather loosely-woven tissue below the hymenium, evidently a form of gloeocystidium.

Hyphae: all hyaline,  $3\text{--}4\ \mu$  diam., some thick-walled, unbranched, non-septate; others with thin walls, branched, septate and with rare clamp connections.

Tissue differentiation: hyphae of the lower part of the trama densely intertexted, upper tissue bearing vesicles more loosely intertexted; there is a narrow pale brown seam of hyphae subtending the abhymenial hairs.

Abhymenial hairs: thin- or thick-walled, free or fasciculate, 3–4  $\mu$  diam., like the hyphae.

Specimens examined: 15523, 36729; A. E. Eaton, Cape, as *S. vorticosum* in Herb. Kew.

Cystidioles are not always present, and may be difficult to see when they are present. The form with cystidioles was once distinguished as *S. rugosiusculum*, but it appears that production of cystidioles is probably dependent on weather conditions. The presence of vesicles is a very helpful diagnostic character for the species. Fructifications of *S. purpureum* are apparently rare in South Africa though the pathological effect of this fungus in producing "silverleaf" disease of fruit trees is quite well known.

Judging from specimens in the National Herbarium, there has been a tendency to confuse *S. purpureum* with the conidial state of *Punctularia affinis* (B. & C.) Talbot. This must have been due to the similarity in their colour alone.

(44) *Stereum pusillum* Berk.; Saccardo Syll. Fung. 6 (1888) 559; Doidge loc. cit. p. 492.

The specimens cited by Doidge have all been examined. Two of them are referred to *S. thozetii*. The other, 31858 (Universiteit van Stellenbosch, Herbarium P. A. van der Byl No. 662) is in rather poor condition, but appears to be *Stereum diaphanum*. *S. pusillum* should be omitted from South African lists.

(45) *Stereum radicans* (Berk.) Burt in Ann. Mo. Bot. Gard. 7 (1920) 108; van der Byl in Ann. Univ. Stellenbosch 7 (1929) 37, Pl. 2, 13; Doidge loc. cit. p. 492.

*Thelephora radicans* Berk. in Hooker's Lond. Journ. Bot. 3 (1844) 190.

#### FIG. 23.

The material on which this record is based was studied in Universiteit van Stellenbosch, Herbarium P. A. van der Byl No. 2384, and another part of it was kindly lent to the writer by Dr. J. C. F. Hopkins from Mycol. Herb. Dept. Agric. S. Rhodesia No. 3878 (Eyles, 4153). A description of this material is appended.

Fructifications terrestrial, thick, distorted, somewhat spatulate or flabellate but rather indefinite in shape. There is no proper stipe but the pileus narrows towards the base and might be considered laterally stipitate. Both surfaces are rugose and radially furrowed. The upper surface has a hint of fine radial striae near the margin. Margin entire, thick. Upper surface coloured chocolate; hymenium almost concolorous but with darker blackish patches suggesting a "bleeding" species. Spores not seen. Hyphae all hyaline, some wide with thick walls; others narrow. Long, deep-staining elements which are a form of conducting vessel are present; they are up to 560  $\mu$  or more in length, unbranched, non-septate, thin-walled (4.8)–6.5–11  $\mu$  wide, very abundant. Other microscopic characters are rather indistinct. The pileus colour suggests a species of *Thelephora*, but the texture is that of a *Stereum*. The context is light-brown in colour.

Burt's description of *S. radicans* states that no cystidia or gloecystidia are present, and this statement is repeated by Martin (in Lloydia 7, 1944, 77). The conducting vessels in Eyles' specimen are so conspicuous that it would seem that it must be unrelated to *S. radicans*, for such a feature could not have been missed if it were present in *S. radicans*. Burt also emphasises the longitudinal striae on the upper surface of the pileus; there is a hint of these in the present specimen, but no more. Martin (loc. cit.) infers that a radicating base is not a constant feature of this species; certainly

it is not shown in Eyles' specimen. Martin further states that his collections approach *Cladoderris*, another feature which casts doubt on the determination of Eyles' specimen as *S. radicans*.

Although there may be similarities in external form with *S. radicans*, the absence of spores and the presence of conductors in Eyles' specimen make a confident identification impossible.

(46) *Stereum ravenelii* Berk. & Curt. in Grevillea 1 (1873) 162; Doidge loc. cit. p. 492.

FIG. 1.

Fructifications coriaceous, terrestrial, centrally stipitate, infundibuliform, 7 mm. radius from attachment, 1.5 cm. diam. Stipe 6 mm. long, 1 mm. wide. Surface glabrous, concentrically furrowed, with red-brown, bay or yellow-brown zones. Hymenium yellow-brown to brownish when dry. Margin thin, entire.

Basidia: compact,  $4.8 \times 26-36 \mu$ .

Spores: abundant, hyaline, smooth, small, ovate or elliptical,  $3.2 \times 4.8 \mu$ .

Gloeocystidia: thin-walled, with homogeneous contents, up to  $12.8 \times 144 \mu$ , with a ventricose base or sometimes widest near the apex, abundant, embedded.

Hyphae: generative hyphae about  $2 \mu$  wide, hyaline, thin-walled with wide lumen, septate, with clamp connections; skeletal hyphae hyaline, about  $5 \mu$  wide, with thicker walls but with a wide lumen.

Specimens examined: Welwitsch (427, 425) ex British Museum Nat. Hist.

Lorrain Smith's determination of these specimens as *S. ravenelii* has been accepted here, as the specimens accord fairly well with Burt's description (in Ann. Mo. Bot. Gard. 7, 1920, 90) and no other material of this species has been available for study. Welwitsch 425 is old material in which the details are obscure. The infundibuliform, bay-coloured pileus, gloeocystidia and small spores appear to be the chief characteristics. In these features, however, the present specimens correspond very closely with *S. nitidulum* (see p. 321) and are only separable by the size of their gloeocystidia and by hyphal characters. It is possible that the specimens treated here as *S. nitidulum* and *S. ravenelii* represent only a single species. If so, that species is more likely to be *S. nitidulum* than *S. ravenelii*.

(47) *Stereum retirugum* Cooke (!) in Proc. Roy. Soc. Edinb. (1882) 456; Doidge loc. cit. p. 492.

Doidge's record of this species refers to Mocambique; there is no material under this name in the National Herbarium, Pretoria. Cooke's type at Kew is synonymous with *Stereum schomburgkii* Berk (!), which is now referred to *Stereum fulvum* (Lév.) Sacc. (!).

(48) *Stereum rimosum* Berk. (!); Recorded by Lloyd in Lloyd Myc. Notes 4 (1913) L. 46, 4; Doidge loc. cit. p. 492.

The writer is of the opinion that this species is not typically represented in South Africa, and the specimens cited by Doidge are all referred to *S. rimosum* Berk. var *africanum* Talbot (see following description).

(49) *Stereum rimosum* Berk. var *africanum* Talbot in Bothalia 4 (1948) 495, Fig. 5; ibid. 6 (1951) 38; Doidge in loc. cit. p. 492.

*Stereum adnatum* Lloyd (!) in Lloyd Myc. Notes 7 (1925) 1336, Fig. 3093; Stevenson & Cash in Bull. Lloyd Library 35 (1936) 49; Doidge loc. cit. p. 487.

FIG 14.

Fructifications effused, resupinate-reflexed, often sessile and attached by a broad umbo, or sometimes only narrowly attached and then composed of several connate, subdimidiate pilei, coriaceous, becoming thickened, lignicolous. Surface cinnamon



buff colour, concentrically furrowed, covered with a thick, felty, pad-like tomentum. Margin even or lobate. Hymenium closely and conspicuously rimose and rugose, sometimes appearing blistered, cracking to show a pallid silky context, often concentrically furrowed, warm buff or pinkish buff in herbarium, yellow when fresh, bleeding when bruised and often drying adustus to cinereous colour especially where bruised. Width in section excluding the tomentum, 700–1000  $\mu$ .

Basidia: closely aggregated, 4–4.5  $\mu$  wide at apex.

Spores: hyaline, smooth, elliptic-ovate, with one side frequently depressed, with a small attenuated apiculus,  $2\text{--}3 \times 3.5\text{--}5.5 \mu$ .

Conducting vessels: yellow, 5.5–8.5  $\mu$  wide, with rigid walls, in a layer about 200  $\mu$  thick, distributed in the subhymenium and curving upwards into the hymenium, not emergent.

Hyphae: thin-walled, hyaline, frequently septate, 3.5  $\mu$  wide.

Tissue differentiation: there is a narrow orange coloured, dense zone subtending the abhymenial surface.

Abhymenial hairs: thick-walled, much intertwined, almost hyaline to pale yellowish, 4.2  $\mu$  diam.

Specimens examined: Type, 30233; 30268, 30777, 28285, 27755, 28296, 28303, 40211, 40217, 27565, 34375, 27772, 34365, 28295, 36891; 1708 (Type of *Stereum adnatum* Lloyd); Universiteit van Stellenbosch, Herbarium P. A. van der Byl No. 1646 (as *Stereum transvaalium* van der Byl); Uganda, Maitland (460, 19 A).

Reasons for reducing *S. adnatum* Lloyd to synonymy with *S. rimosum* var *africanum* are given in *Bothalia* 6 (1951) 39.

The variety *africanum* was described as "not differing from the type in microscopic appearance, with a resupinate-reflexed habit (neither pileate nor sessile-umbonate), with a thicker tomentum, with a rougher, paler and more zonate hymenium" (Talbot in *Bothalia* 4, 1948, 945). With further specimens to hand, some are now included which are only narrowly resupinate, and in others the hymenial colour is predominantly cinereous with only patches of yellowish colour remaining. The change to cinereous colour is definitely associated with the ability of this fungus to "bleed" when bruised. Thick specimens showing a perennating tendency have been collected.

(50) *Stereum rubiginosum* Fries. Recorded under this name by Montagne in *Ann. Sci. Nat. ser iii*, 7 (1847) 174.

A specimen has not been seen by the writer, but "*Stereum rubiginosum* Fr." is a synonym of *Hylaenochaete rubiginosa* Dicks. ex Lev. This is noted by Doidge loc. cit. p. 485.

(51) *Stereum rugosum* (Pers.) Fr. Doidge loc. cit. p. 492 records two specimens under this name.

W. Nelson, Hout-Bosch Berg, 1880, in Kew Herbarium has been seen by the writer and is referred to *S. rimosum* var *africanum*. No. 34394 is a young species of *Stereum*, but not *S. rugosum*. It lacks conductors and also differs in habit and colour. There is a third specimen in Pretoria as *S. rugosum*, No. 35559, which proves to be *S. durbanense* van der Byl.

(52) *Stereum sanguinolentum* (Alb. & Schwein. ex Fr.) Fr., *Epicrisis* (1838) 549, *Hym. Eur.* (1874) 540; *Saccardo Syll. Fung.* 6 (1888) 564; Doidge in loc. cit. p. 493; Talbot in *Bothalia* 6 (1951) 37.

*Thelephora sanguinolenta* Alb. & Schwein., *Consp. Fung.* (1805) 274; *Fries Syst. Myc.* 1 (1821) 440, *Elenchus Fung.* 1 (1828) 178.

#### FIG. 15.

Fructifications coriaceous, lignicolous, thin, resupinate or effused becoming narrowly reflexed, orbicular-confluent. Margin acute, pallid. Surface villous-strigose, with short, adpressed, silky hairs, zonate and striate, whitish to some tint of buff.

Hymenium more or less cinereous when fresh, becoming light brown, smooth or cracking rimosely to show a silky subiculum, often zonate. Flesh exuding a reddish juice when wounded in fresh state. In section 400–500  $\mu$  thick.

Basidia: clavate, 26–40  $\times$  4.5–6.5  $\mu$ .

Spores: hyaline, smooth, cylindrical, unilaterally depressed (6.4)–8–(9)  $\times$  3–3.5  $\mu$ .

Conducting vessels: conspicuous, reddish-brown, numerous, in the intermediate tissues and curving upwards into the hymenium, 3–4–(9)  $\mu$  wide, very occasionally forked, walls hyaline, smooth, occasionally thickened.

Hyphae: hyaline, 2.5–5  $\mu$  diam., with thin, firm walls and a wide lumen, without clamps, septate, sometimes branched, densely interwoven in a more or less horizontal direction.

Tissue differentiation: There is a narrow, dense, yellowish-brown zone subtending the abhymenial surface.

Abhymenial hairs: simple, thick-walled, agglutinated, short, adpressed, 4–5  $\mu$  diam.

Specimens examined: 28933, 33248, 40462, 40494.

..... *Stereum sanguinolentum* is usually considered a North Temperate species, and was possibly introduced to South Africa on imported conifers. Its thin, almost papery texture and its occurrence on conifers is at once a difference from all other South African species of *Stereum* possessing conducting vessels. *S. sanguinolentum* is suspected of causing a serious disease of *Pinus taeda* in Northern Natal.

(53) *Stereum schomburgkii* Berk. (!) in Journ. Linn. Soc. Bot. 13 (1873) 168; Saccardo Syll. Fung. 6 (1888) 568; Talbot in Bothalia 6 (1951) 43; Doidge loc. cit. p. 493.

= *Stereum fulvum* (Lév.) Sacc. (!). See p. 315.

(54) *Stereum spadiceum* Fr.; Recorded by Lloyd in Lloyd Myc. Notes 4 (1913) L. 46, 8; Brown in S.A. Journ. Sci. 33 (1936) 388; Doidge in loc. cit. p. 493.

All the specimens cited by Doidge have been seen. Mrs. Brown's material is *Stereum australe* Lloyd. The other specimens all lack conductors and are characteristic *Stereum hirsutum*.

(55) *Stereum subpileatum* Berk.; Recorded by Lloyd in Lloyd Myc. Notes 5 (1917) L. 66, 15, Note 634; Doidge in loc. cit. p. 489.

The material cited by Lloyd was made the type of *Stereum durbanense* van der Byl (see p. 312). *Stereum subpileatum* does not occur in South Africa.

(56) *Stereum tabacinum* Sow. ex Fr. var *australis* Mont.; Recorded by Kalchbrenner in Grev. 10 (1881) 58; Doidge loc. cit. p. 485.

The writer has not seen MacOwan's material on which this record is based. *Stereum tabacinum* var *australis* is a synonym of *Hymenochaete tabacina* (Sow. ex Fr.) Lev.

(57) *Stereum tenebrosum* Lloyd (!), *nomen nudum*, in Lloyd Myc. Notes 5 (1918) L. 67, p. 16; Doidge loc. cit. p. 493.

This species is sunk under *Stereum australe* Lloyd, for reasons given on p. 307.

(58) *Stereum thozetii* Berk. Austral. Fung. No. 268; Saccardo Syll. Fung. 6 (1888) 557; Doidge loc. cit. p. 493.

### FIG. 3.

Fructifications soft-coriaceous, terrestrial among grass, perhaps on grass roots, solitary or sometimes gregarious and then 2–3 pilei from separate stems may fuse above into a single connate pileus; centrally stipitate, infundibuliform becoming

somewhat flattened and discoid later. Pileus 0.4–2 cm. radius from the attachment, the disc 0.7–3 cm. diam., larger sizes often resulting from fusion of up to 3 pilei. Stipe 4 mm. long, 1 mm. wide, smooth or pruinose, creamy to light-brown colour. Surface of pileus glabrous to pruinose, not tomentose or velutinate, concentrically zoned in shades of pale yellow-brown to red-brown or brown. Hymenium smooth, creamy or whitish in colour. Margin thin, entire, undulate, concolorous. Thickness in section 400–1100  $\mu$ .

Basidia: cylindric-clavate,  $26\text{--}35 \times 4\text{--}6.6 \mu$ , with 4 sterigmata.

Spores:  $4.8\text{--}6.4 \times (6.4)\text{--}7.2\text{--}9.6 \mu$ , hyaline, smooth, frequently uniguttulate, broad ovate to broad elliptical, sometimes showing a small apiculus, thin-walled.

Gloeocystidia: usually abundant and long,  $3.2\text{--}9.6 \mu$  wide  $\times$   $66\text{--}186 \mu$  (or more) long, hyaline, arising from generative hyphae, sometimes showing a basal clamp, subcylindrical, sometimes somewhat ventricose at the base, at other times not at all swollen and completely hyphoid, thin-walled, smooth, with homogeneous deep-staining contents.

Hyphae: skeletal hyphae hyaline, not staining, usually thick-walled, occasionally branched, not septate,  $2.4\text{--}3.2 \mu$  diam.; generative hyphae hyaline, thin-walled, staining deeply,  $1.5\text{--}3.2 \mu$  diam., smooth, with occasional clamp connections, branched, septate.

Tissue differentiation: There are no abhymenial hairs, nor is a dense zone differentiated below the abhymenial surface.

Specimens examined: 8933, 31456, 13009, 8807, 28895; Herb. S. Afr. Museum No. 45947; Herb. S. Afr. Museum No. 34266 (MacOwan 1232).

The identification of this species was checked at Kew by Dr. Dennis. In the National Herbarium this species was formerly confused with *S. pusillum* and *S. nitidulum*, while MacOwan's collection cited above was originally determined as *S. elegans*. As far as can be ascertained neither *S. elegans* nor *S. pusillum* occur in South Africa, and *S. nitidulum* may be distinguished from *S. thozetii* by the bay-zonate pileus of the former and its smaller spores.

(59) *Stereum tomentosum* van der Byl (!) in Trans. Roy. Soc. S. Afr. 10 (1922) 156 Fig. 9, in Ann. Univ. Stellenbosch 7 (1929) 45; Doidge loc. cit. p. 493.

= *Stereum durbanense* van der Byl (!). See p. 312.

(60) *Stereum transvaalium* van der Byl (!) in Ann. Univ. Stellenbosch 7 (1929) 40; Doidge loc. cit. p. 494.

Two specimens are preserved under this name in the Universiteit van Stellenbosch, Herbarium P. A. van der Byl Nos. 1472 and 1646. No. 1472 is taken to be the Type, since it is the only specimen cited in van der Byl's latin description of the species. Most of his description, however, appears to be taken from No. 1646, or at least it is compounded from both specimens, which are both cited in the Afrikaans text.

In the writer's opinion, No. 1472 cannot be differentiated from *Stereum australe*, while No. 1646 is referred to *Stereum rimosum* var. *africanum*. The fact that the description was partly based on this specimen of *S. rimosum* var. *africanum* may be the reason why van der Byl stated that the general appearance of the fruit-bodies differentiated them easily from *S. australe*.

*Stereum transvaalium* must be taken either as a synonym of *Stereum australe*, or as a *nomen confusum*.

(61) *Stereum turgidum* Lloyd (!) in Lloyd Myc. Notes 5 (1916) L. 63, 15, Note 502; Doidge loc. cit. p. 494.

Lloyd (in Lloyd Myc. Notes 4, 1916, 549, Fig. 751) first described this species under the name *Stereum caperatum* Lloyd, but as this was a later homonym of *S. caperatum* (Berk. & Mont.) Massee, he later changed its name to *S. turgidum*. For



reasons given in *Bothalia* 6 (1954), p. 339, this species is regarded as synonymous with *Stereum cinerascens* (Schw.) Massee (!).

(62) *Stereum umbrinum* Berk. & Curt. (!) in *Grevillea* 1 (1873) 164; Doidge loc. cit. p. 494; Talbot in *Bothalia* 6 (1951) 41.

*Hymenochaete vinosa* (Berk.) Cooke (!) in *Grev.* 8 (1880) 149; Saccardo *Syll. Fung.* 6 (1888) 600.

*Hymenochaete scabriseta* Cooke (!) in *Ravenel, Fung. Amer.* (1882) 717.

*Hymenochaete purpurea* Cooke & Morgan (!) apud Cooke in *Grev.* 11 (1883) 106.

*Hymenochaete kalchbrenneri* Massee (!) in *Journ. Linn. Soc. Bot.* 27 (1890) 116; Saccardo *Syll. Fung.* 9 (1891) 230.

#### FIG. 19.

Resupinate, effused, sometimes narrowly reflexed, never pileate. Margin shortly villose. Context soft, spongy. Hymenium velutinous, cracking but little in drying, sometimes pitted, umber, vinaceous purple, purple-brown, light sandy brown or snuff brown in colour.

Basidia: hyaline or very faintly coloured, about  $6 \times 30 \mu$ .

Spores: cylindrical or ellipsoid, hyaline, smooth,  $6-8 \times 3-4 \mu$ .

Cystidia: originating in the basal or middle part of the trama, curving up into the hymenium and frequently projecting  $10-20 \mu$  beyond; dark yellow-brown, lighter colour when young or when emergent, not very thick-walled, encrusted or rugose especially near the apex, rarely quite smooth,  $100-250 \times 7-9 \mu$ , cylindric-clavate or fusoid, arising as apical modifications of the skeletal hyphae.

Hyphae: skeletal hyphae  $6.4-9.6 \mu$  diam., yellow-brown, unbranched, without septa; generative hyphae lightly coloured,  $3.4-5-(6) \mu$  diam., thin-walled, branched, septate, without clamps.

Tissue differentiation: the tissues are formed of loosely interwoven hyphae without any denser abhymenial zone.

Specimens examined: 20974, 22044, 30220, 27626, 28294, 28702, 28276, 28277, 27767, 33392, 33400, 34357, 34393, 35419, 34381, 36839, 36710; van der Byl (2737) in *Herb. Kew.*; MacOwan (1055) sub *Hymenochaete pellicula* in *Herb. S. Afr. Museum* No. 34315; MacOwan (1054) sub *Peniophora cinerea* in *National Herbarium*.

The cystidia of this species are apically modified skeletal hyphae. They do not darken in alkali and in some specimens lack conspicuous incrustation or roughness, but they are quite different from setae. The lack of a distinctive horizontal layer of densely interwoven hyphae as an intermediate or basal tissue is characteristic of relatively few species of *Stereum*. Its closest affinity is with *S. papyrinum* Mont. (!) (= *S. membranaceum* Fr.), which is frequently pileate and always possesses wider, more encrusted, more peniophoroid cystidia with thicker walls. Most South African specimens of *S. umbrinum* have a purplish tinge rather than the typical umber colour.

(63) *Stereum vellereum* Berk.; Doidge loc. cit. p. 494; van der Byl in *Trans. Roy. Soc. S. Afr.* 10 (1922) 156, in *Ann. Univ. Stellenbosch* 7 (1929) 47; Lloyd in *Lloyd Myc. Notes* 5 (1917) L. 66, Note 584.

Lloyd's conception of this species, which has been followed in South Africa is that it is a fungus very like *Stereum hirsutum* but differing in being somewhat thinner and having very pale or colourless surface hairs instead of the more yellow-brown hairs of *S. hirsutum*. Microscopically there is no difference. The writer is doubtful whether these distinctions are sufficiently marked to merit a different specific name.

The following specimens examined show the pale to colourless surface hairs and might be considered as *S. vellereum*: Universiteit van Stellenbosch, Herbarium P. A. van der Byl Nos. 1717 (Eyles 3892), 2229, 143, 191, 147; National Herbarium, Pretoria Nos. 15610, 30879.

(64) *Stereum versicolor* (Swartz ex Fr.) Fr.; Doidge loc. cit. p. 494.

The writer has not seen all the specimens cited by Doidge, but those seen are not referable to *S. versicolor*. MacOwan (1276, 1163, as *Stereum versicolor*, Herb. S.A. Museum 34265) is referred to *Stereum lobatum*.

(65) *Stereum (Hymenochaete) villosum* Lév.; Recorded by Lloyd in Lloyd Myc. Notes 5 (1916) L. 63, 2.

The specimen referred to (No. 15558) is *Hymenochaete luteobadia* (Fr.) Höhnelt & Litsch. Doidge loc. cit. p. 485 cites *Stereum villosum* Lév. as a synonym of *Hymenochaete nigricans* (Lév.) Bres. This synonymy is also given by Bresadola (in Ann. Myc. 14, 1916, 232). The present specimen is however not *H. nigricans*.

(66) *Stereum vitile* Fries, Fungi Natalenses (1848) 23; Doidge loc. cit. p. 494.

Doidge notes that "fide Wakefield this fungus has not been recognised since the original collection and it is doubtful whether a specimen exists".

A fungus not unlike *Stereum umbrinum* is called for from Fries' description, and affinity with this species is suggested by Saccardo in Sacc. Syll. Fung. 6 (1888) 569, and repeated by Massee in Journ. Linn. Soc. Bot. 27 (1890) 193.

(67) *Stereum vorticosum* Fr.; Recorded by Berkeley in Journ. Bot. London 14, n.s. V (1876) 175; Doidge loc. cit. p. 492.

Berkeley's material was borrowed from Kew Herbarium. It was labelled "*Stereum vorticosum* Fr. Pale form. Cape. A. E. Eaton", and proved on examination to be in no way different from *Stereum purpureum*.

#### Key to accepted species of *Stereum*:—

1. Pilei infundibuliform and centrally stipitate. 2.  
Pilei not infundibuliform nor centrally stipitate. 7.
2. With gloecystidia (some may be interpreted as smooth cystidia). 3.  
Without gloecystidia. Here may be located some rare forms of *Stereum lobatum* (29) which are infundibuliform by fusion and thus often partially split down one side.
3. Without surface hairs. Sections do not show any well-marked denser coloured zone immediately beneath the abhymenial surface. 4.  
With (scanty) surface hairs. Sections show a well-marked denser coloured zone beneath the abhymenial surface. Here are located unusual forms of *S. affine* (2) which are usually only infundibuliform by fusion and thus are often partially split down one side.
4. Spores, small, ovate, broad-elliptic or subglobose, not larger than  $3-4 \times 4-5 \mu$ . 5.  
Spores, larger, in the range of  $3-6 \times 6.5-9 \mu$ . 6.
5. Gloecystidia up to  $12.8 \times 144 \mu$  in size. *S. ravenelii* (46).  
Gloecystidia smaller, up to  $10.5 \times 80 \mu$ . *S. nitidulum* (34).
6. Gloecystidia usually rather narrow ( $3.2-9.6 \mu$  wide) and often hyphoid. Hyphae of two types, some with clamp connections. *S. thozetii* (58).  
Gloecystidia usually wider ( $8-9.6-16 \mu$  wide) and clavate. Hyphae of one type only and without clamps. *S. diaphanum* (15).
7. Pilei laterally stipitate, or flabellate or spatulate, or sessile and cuneate attached by a markedly reduced base. 8.  
Pilei dimidiate or effuso-reflexed or resupinate. 13.
8. Fresh pilei bleeding red when bruised. Conducting vessels present microscopically in fresh or dried plants. *S. australe* (6).  
Fresh plants not bleeding. Conducting vessels absent. 9.
9. Without gloecystidia or cystidia. 10.  
With gloecystidia or cystidia, or both together. 11.

10. Pilei small (up to 1 cm. in any direction), soft, whitish, without colour zones on the surface. Spores pip-shaped or later distorted and angled. Hyphae monomitic. *S. cyphelloides* (14).  
 Pilei large, coriaceous or tough, surface coloured with zones of grey, brown, chestnut. Spores cylindric-depressed. Hyphae dimitic. *S. lobatum* (29).
11. With gloeocystidia but no cystidia. Pilei with a definite stipe, flabellate, spatulate or infundibuliform. *S. affine* (2).  
 With both gloeocystidia and cystidia. 12.
12. Pilei usually merismatoid, i.e. a compound fructification consisting of a number of smaller pilei growing together in a bush. Gloeocystidia  $7-10 \times 40-66 \mu$ . *S. involutum* [26]  
 Pilei not merismatoid, but single or sometimes dimidiate or fused laterally. Gloeocystidia smaller  $7-12 \times (15)-25-(40) \mu$ . Here is located the species represented by *S. bellum* (7) and *S. friesii* (20) in the sense used by van der Byl.
13. Without cystidia, cystidioles, gloeocystidia, vesicles or conducting vessels (distinguish carefully between skeletal hyphae which intrude into the hymenium and conductors or cystidia). 14.  
 With any of the following organs: cystidia, cystidioles, gloeocystidia, vesicles, conducting vessels (Avoid locating here species which have intrusive skeletal hyphae unless these are much swollen like cystidia at the apex). 18.
14. Mature pilei small (1 cm. or less) soft, whitish, azonate. Spores pip-shaped becoming angularly distorted. Hyphae monomitic. *S. cyphelloides* (14).  
 Mature pilei larger, or if immature then either not whitish or possessing more than one type of hypha. 15.
15. Skeletal hyphae in context brown. The skeletal hyphae which curve up into the hymenium are brown, rugose or encrusted. Hymenium usually dark-coloured, only rarely yellowish or light-coloured. [Compare also *S. umbrinum* (62) where the skeletal hyphae are much expanded and resemble cystidia in the hymenium.] *S. fulvum* (21).  
 Skeletal hyphae in the context not brown, but at the most only pale straw-coloured or hyaline. Hymenium not dark, usually creamy, yellow, orange, fawn or sometimes changing to cinereous. 16.
16. Pileus with multi-coloured zones on the surface, usually flabellate, or if a uniform brown colour then the pilei are relatively large and flabellate. *S. lobatum* (29).  
 Pileus without multi-coloured zones on the surface, or zoned in shades of brown; usually smaller than *S. lobatum* and effuso-reflexed or dimidiate, not flabellate. 17.
17. Pileus thin, coriaceous, effuso-reflexed or dimidiate with a shortly villose or matted hairy surface. *S. hirsutum* (24).  
 Pileus thicker (usually more than 1 mm. thick) corky or subligneous, effuso-reflexed, with a thick padlike tomentum of ochraceous to golden hairs. *S. durbanense* (16).
18. Fresh pilei bleeding red when bruised. Fresh or dried specimens possessing conductors in the hymenial layer. 19.  
 Fresh pilei not bleeding, lacking conductors at all times. 21.
19. Pilei generally dimidiate or cuneate with a reduced base, rarely widely effuso-reflexed. Hyphae dimitic. Hymenium cinereous, smooth. *S. australe* (6).  
 Pilei mostly resupinate-reflexed, rarely dimidiate. 20.
20. Hymenium rimose, i.e. blistered and cracking into small rough areas, yellow, tan or cinereous. Not on conifers. Hyphae dimitic. Usually more than  $700 \mu$  thick. *S. rimosum* var *africanum* (49).  
 Hymenium smooth, not rimose, cinereous to light brown. Occurring on conifers. Hyphae monomitic. Usually less than  $600 \mu$  thick. *S. sanguinolentum* (52).
21. Species possessing pyriform or subglobose vesicles embedded deep in the trama (some of the vesicles are sometimes elongated and must be distinguished from gloeocystidia). 22.  
 Species without vesicles. 23.
22. Fructifications more or less resupinate, sometimes narrowly reflexed, stratoses with a veined or marbled subligneous context and a glabrous black abhymenial surface showing as a black line in wholly resupinate specimens. Hymenium yellowish. *S. murrayi* (33).  
 Fructifications effuso-reflexed or dimidiate, not stratoses or veined, with a hairy brownish surface. Hymenium purple to purple-brown. *S. purpureum* (43).
23. Species with cystidia but lacking gloeocystidia. 24.  
 Species with gloeocystidia and sometimes cystidia as well. 25.
24. Cystidia large ( $12-24 \mu$  wide) conical or fusoid, encrusted, hyaline or only dilutely coloured. Spores averaging  $6 \times 11 \mu$ . Hymenium light-coloured. *S. cinerascens* (11).



Cystidia dark yellow-brown, subhyaline where emergent, actually only apically swollen and encrusted or rugose skeletal hyphae (rarely smooth at apex). Spores  $3-4 \times 6-8 \mu$ . Hymenium usually umber brown or purplish, rarely a light sandy brown. [Compare *S. fulvum* (21) whose skeletal hyphae in the hymenium are less like cystidia, being not much expanded and roughly cylindrical.] *S. umbrinum* (62).

25. Species with gloecystidia but no cystidia. 26.  
Species with both gloecystidia and cystidia. 27.
26. Context pale creamy to pale yellow-brown, usually stratose. Spores subglobose,  $6-7 \mu$  diam. (Gloeocystidia sometimes seen with difficulty.) *S. duriusculum* (17).  
Context brown, contrasting with a hyaline hymenial layer. Spores  $3-4.5 \times 2-3 \mu$ . Gloecystidia abundant, sometimes fragmented and refractile like cystidia. *S. bicolor* (8).
27. Cystidia and gloecystidia clearly differentiated. Context pale-coloured throughout. Hyphae hyaline. Here may be located the species represented by *S. bellum* (7) and *S. friesii* (20) in the sense of van der Byl.  
Only gloecystidia present, but older ones are fragmented and highly refractile thus resembling cystidia or mineral aggregations. Context brown, contrasting with a hyaline hymenial layer. Basal hyphae mostly brown. *S. bicolor* (8).

### EXPLANATION OF THE ILLUSTRATIONS.

The following lettering has been used throughout the illustrations:—

B = Basidia.	C = Cystidia.
S = Spores.	CY = Cystidioles.
G = Gloecystidia.	V = Vesicles.
SH = Skeletal hyphae.	CV = Conducting vessels.
GH = Generative hyphae.	IH = Intrusive skeletal hyphae in the
H = Surface hairs.	hymenium.

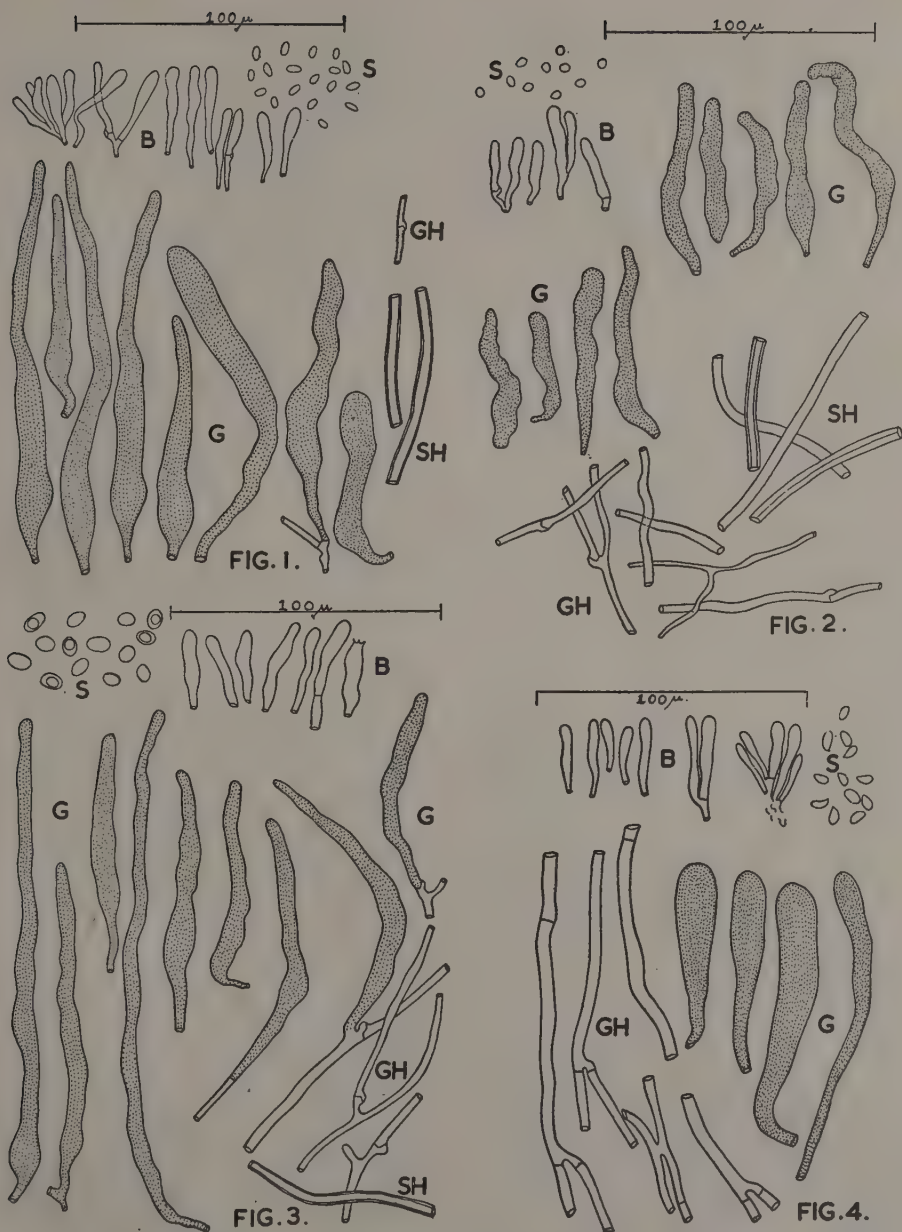


FIG. 1.—*S. ravenelii*. FIG. 2.—*S. nitidulum*. FIG. 3.—*S. thozetii*.  
FIG. 4.—*S. diaphanum*.

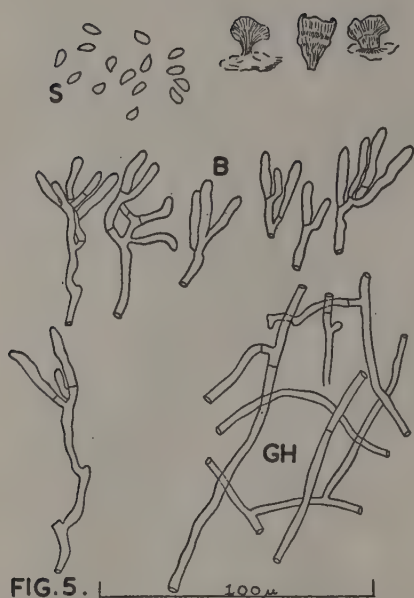


FIG. 5.

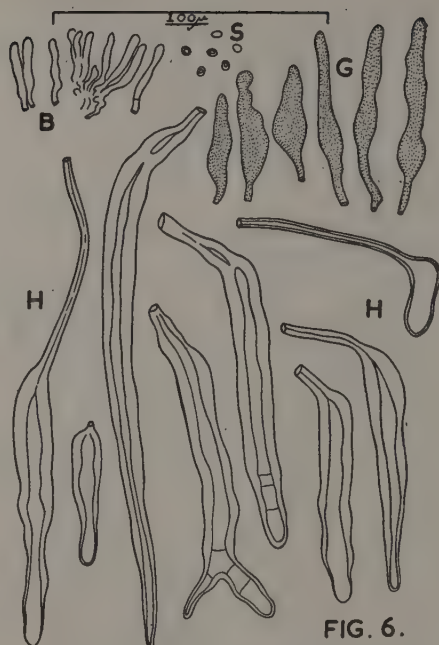


FIG. 6.

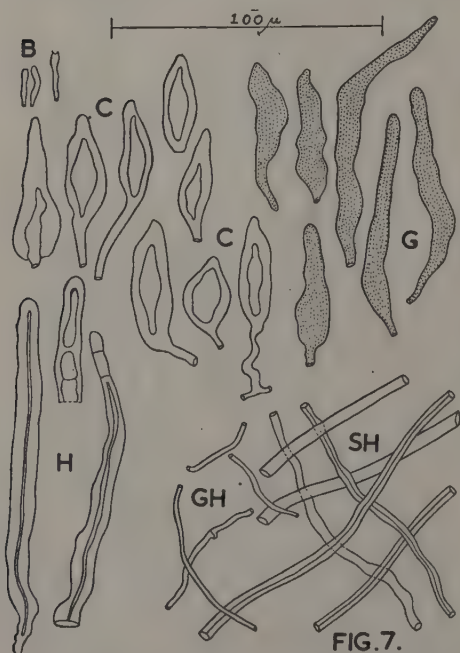


FIG. 7.

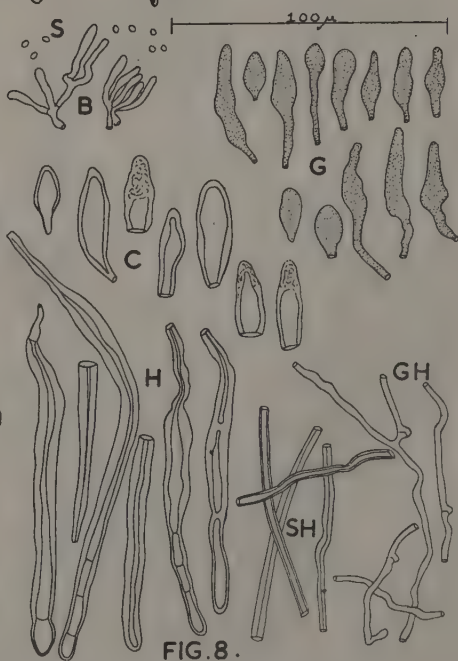


FIG. 8.

FIG. 5.—*S. cyphelloides*. FIG. 6.—*S. affine*. FIG. 7.—*S. involutum*.  
FIG. 8.—van der Byl (1945) as *Stereum bellum*.



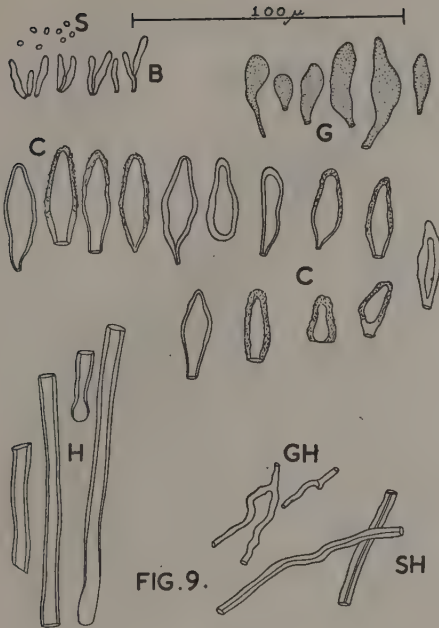


FIG. 9.

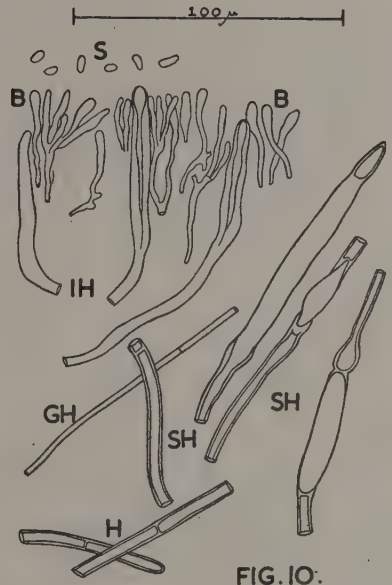


FIG. 10.

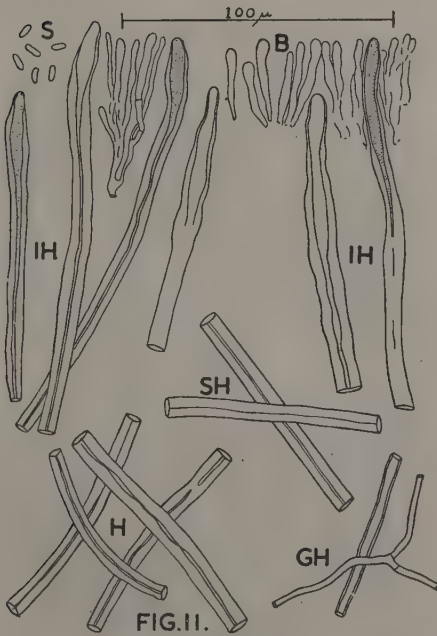


FIG. 11.

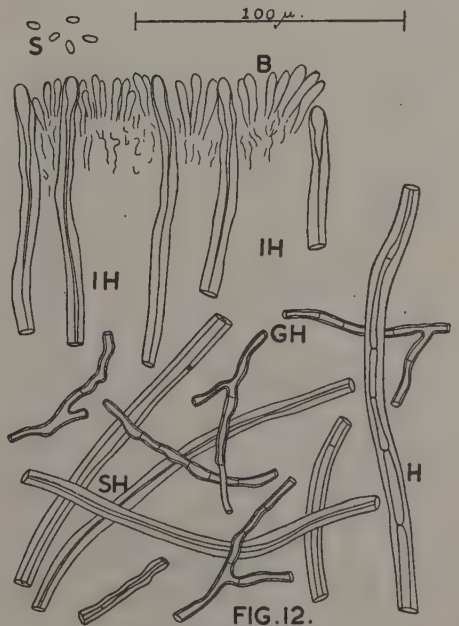


FIG. 12.

FIG. 9.—van der Byl (378) as *Stereum friesli*. FIG. 10.—*S. lobatum*.  
FIG. 11.—*S. hirsutum*. FIG. 12.—*S. durbanense*.

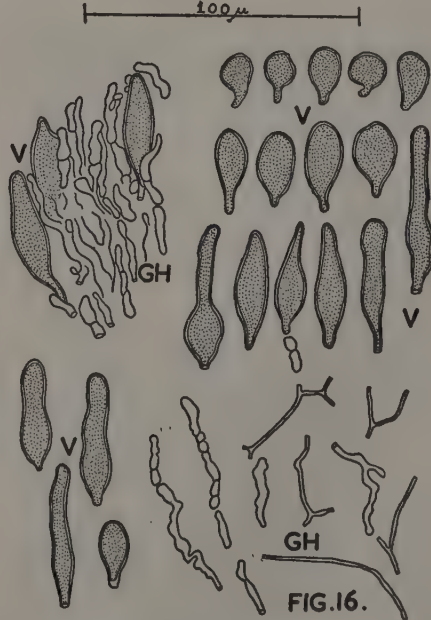
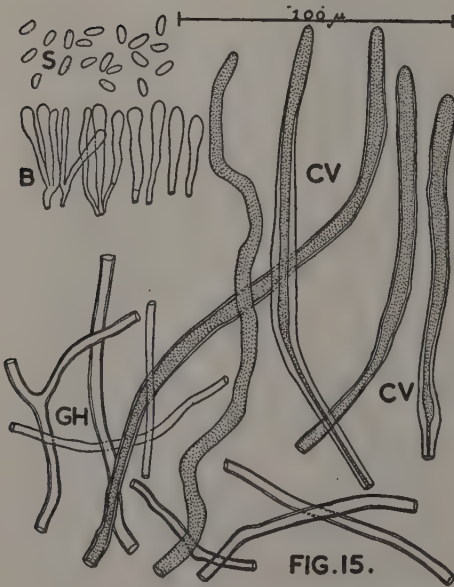
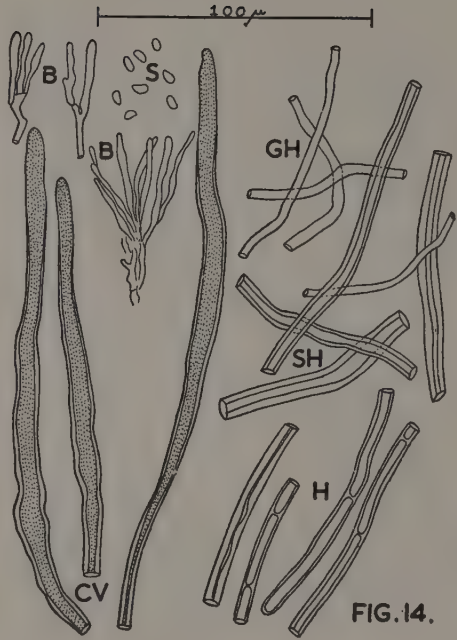
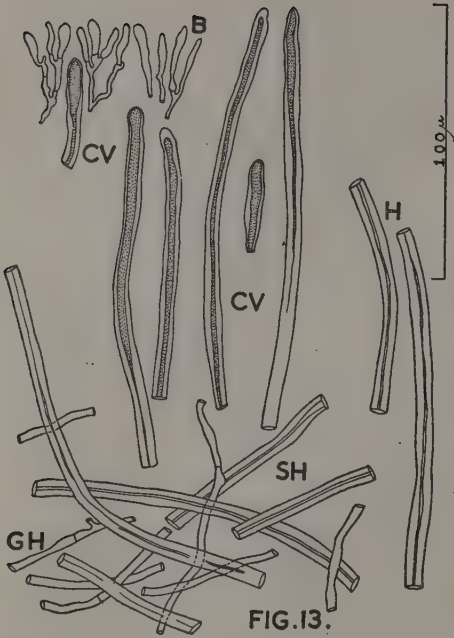


FIG. 13.—*S. australe*. FIG. 14.—*S. rimosum* var *africanum*.  
FIG. 15.—*S. sanguinolentum*. FIG. 16.—*S. murrayi*.

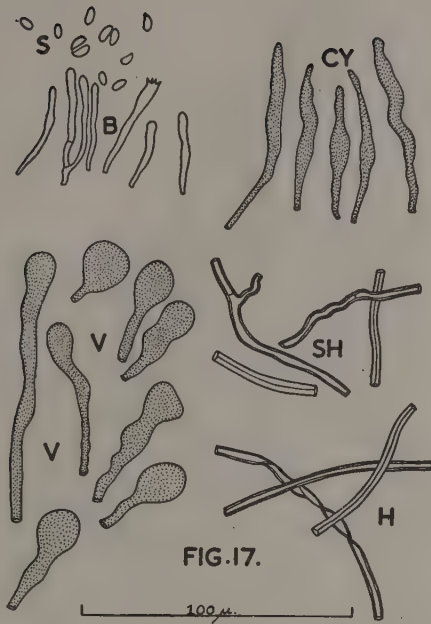


FIG. 17.

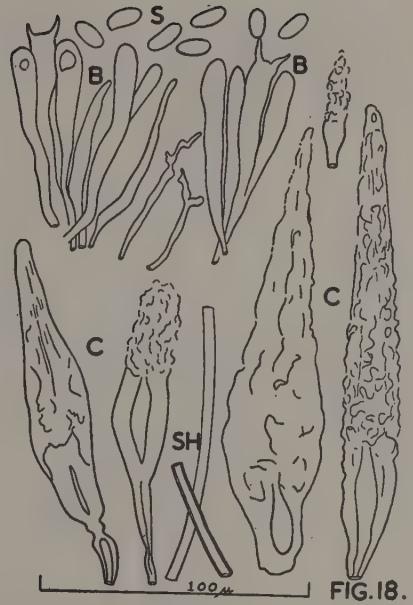


FIG. 18.

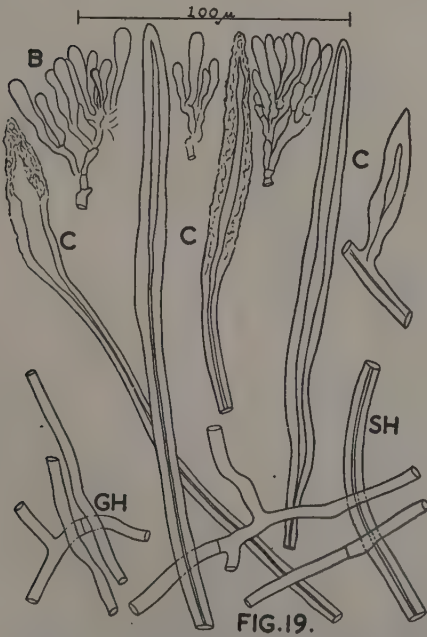


FIG. 19.

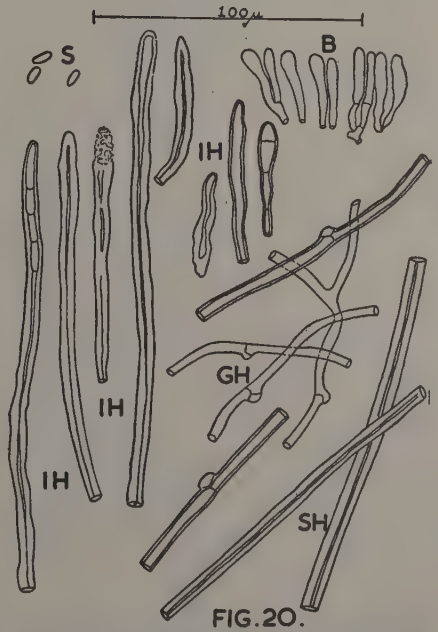


FIG. 20.

FIG. 17.—*S. purpureum*. FIG. 18.—*S. cinerascens*. FIG. 19.—*S. umbrinum*.  
FIG. 20.—*S. fulvum*.



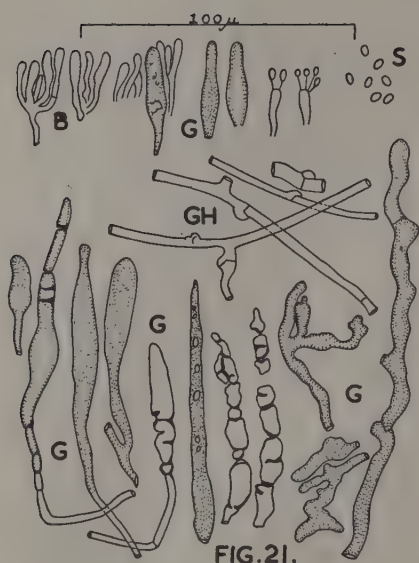


FIG. 21.

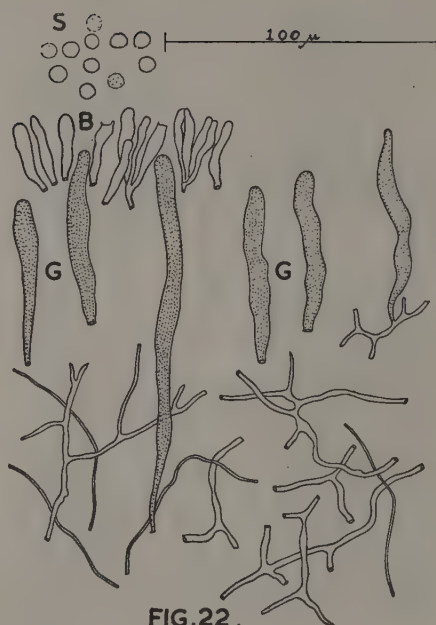


FIG. 22.

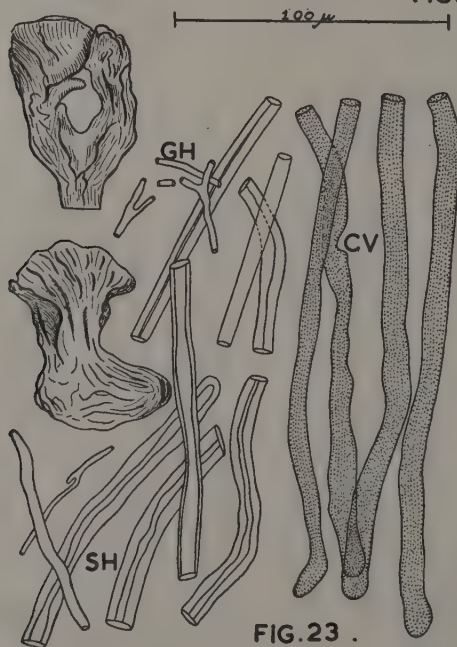


FIG. 23.

FIG. 21.—*S. bicolor*. FIG. 22.—*S. duriusculum*. FIG. 23.—Eyles (4153) as *S. radicans*.

# On the Genus *Lopharia* Kalchbrenner & MacOwan.

By

P. H. B. Talbot.

## Summary.

Four species of *Lopharia* have previously been described. Of these, *L. lirellosa* Kalchbr. & MacOwan is regarded as a synonym of *L. mirabilis* (B. & Br.) Pat. It is shown that the external morphology of the hymenium, upon which the genus *Lopharia* is based, is a variable and unreliable character. Over several collections, intergrading states of the hymenium link the species *L. mirabilis*, *Stereum turgidum* Lloyd and *Stereum cinerascens* (Schw.) Massee, and no constant differences can be demonstrated in the internal structure of these three species. *S. turgidum* and *L. mirabilis* are accordingly recognised as synonyms of *Stereum cinerascens*, and the genus *Lopharia* is sunk under the genus *Stereum* Pers. ex S. F. Gray.

*Lopharia dregeana* (Berk.) Talbot is found to be cospecific with *Irpex vellereus* B. & Br., and the new combination *Irpex dregeanus* is made. It is suggested that *Lopharia javanica* P. Henn. & E. Nym. may be based on a collection of *Lopharia mirabilis* with immature spores. A sporograph supports this supposition, but detailed evidence is lacking as the type of *L. javanica* was not available for study.

The writer examined type or authentic material of most of the species discussed here. Such material is indicated by an exclamation mark (!) after the specific epithets listed in this paper.

## History of the genus *Lopharia*.

In 1873, Berkeley & Broome described *Radulum mirabile* from Ceylon, in the following words (in Journ. Linn. Soc. Bot. 14, p. 61):—

558 *RADULUM MIRABILE*, B. & Br. *Primum orbiculare tomentosum, demum confluens; hymenio perfecto hispidulo* (No. 328). *On dead wood. 5 inches long, 2 broad.*

From this description it is certain that the species could not be recognised again, but the type specimen was preserved in Kew Herbarium, where Massee studied it and in 1892 (in Grevillea 21, p. 2, Pl. 182, fig. 8-9) erected a new genus, *Thwaitesiella*, with the single species *T. mirabilis* (B. & Br.) Massee. The description and illustrations were competently executed.

Meanwhile, in 1881, Kalchbrenner and MacOwan had erected the genus *Lopharia* (in Grevillea 10, p. 58) on the single species *L. lirellosa*, with the following diagnosis:—

*LOPHARIA*, K. et M. On. *Hymenium cartilagineo-membranaceum glabrum, contiguum, in rugas interruptas, cristato-incisas elevatum, Phlebiae maxime affine; sed in hac rugae acie integerrima gaudent.*

*LOPHARIA LIRELLOSA*, K. et M. On. *Effusa, plana, pallide rufescenti carnea, subpruinosa, ambitu determinato, villosa-ciliatulo, albidior; plicis interruptis, varie curvatis, subramosis, cristato-incisas. Somerset East (l. MacOwan). Ligno arcte adnata, placas oblongas formans. Plicae ad formam lirellarum Graphidis eurvatae.*

In 1895, Patouillard (in Bull. Soc. Myc. de Fr. 11, pp. 13-15, Pl. 1) recognised two species of *Lopharia*, viz. *L. lirellosa* and *L. mirabilis*, the latter being transferred from the genus *Radulum*. Masee's genus *Thwaitesiella* lapsed into synonymy. Patouillard distinguished the two species on the disposition of the hymenial crests and teeth, which he stated were more or less concentric and radiating about a central papilla in *L. mirabilis*, but irregular in *L. lirellosa*. He observed that the specific difference was but slight and that the two were generically inseparable. He commented on the similarity in internal structure of *Lopharia* and *Stereum* but differentiated the two by the external appearance of the hymenium, which is smooth in *Stereum*. He noted that young specimens of *L. mirabilis* were smooth and resembled a resupinate, orbicular *Stereum*. In effect, he said that *Stereum* was a simple form related to the more highly developed *Lopharia* and *Cladoderris* forms, between which there were obvious similarities.

With the accumulation in the herbaria of specimens determined as *L. mirabilis* and *L. lirellosa*, it has become evident that their separation on the basis suggested by Patouillard is untenable. Their type specimens may show minor differences, but no specific difference is maintained when a large number of collections is examined. The hymenial configuration is variable and intergrades between the two forms even in a single collection. Petch (in Ann. Roy. Bot. Gard. Perad. 4, 1910, 410) noted von Höhnelt's opinion that the two species might be identical. After examining the types and several other collections of both, the writer is convinced that they are synonymous and henceforth in this paper refers both to the species *L. mirabilis*. He is aware that other mycologists have recognised this synonymy in practice, but was able to find only one statement of it in the literature at his disposal (van der Byl, 1934, loc. cit. infra), and accordingly published the following nomenclator (in Bothalia 6, 1951, 56). *Stereum turgidum* is now added to this list of species:—

*Lopharia mirabilis* (B. & Br.) Patouillard in Bull. Soc. Myc. de Fr. 11 (1895) 14, Pl. 1, Essai Taxon. sur les Hym. (1900) 74; Petch in Ann. Roy. Bot. Gard. Perpa. 4 (1910) 410; van der Byl in Ann. Univ. Stellenbosch 12 (1934) 2, fig. 1.

*Radulum mirabile* B. & Br. (!) in Journ. Linn. Soc. Bot. 14 (1873) 61; Saccardo, Syll. Fung. 6 (1888) 496.

*Thwaitesiella mirabilis* (B. & Br.) Masee in Grevillea 21 (1892) 3, Pl. 182, fig. 8-9.

*Lopharia lirellosa* Kalchbr. & MacOwan (!) in Grevillea 10 (1881) 58; Patouillard (1895, loc. cit.).

*Licentia yao-chanica* Pilát in Ann. Mycol. 38 (1940) 66, text fig. 2, Tab. 1, figs. 1-3.

*Stereum turgidum* Lloyd (!) in Lloyd Myc. Writ. 5 (1916) L. 63, Note 502; Stevenson & Cash in Bull. Lloyd Library 35 (1936) 58.

*Stereum caperatum* Lloyd (!) in Lloyd Myc. Writ. 4 (1916) 549, fig. 751. [non *S. caperatum* (Berk. & Mont.) Masee].

The writer has not seen specimens of *Licentia yao-chanica*, but Pilát's description, photographs and figures leave no doubt that this is the same species as *Lopharia mirabilis*, and that the genus *Licentia* should lapse.

In the paper referred to above (Talbot, loc. cit.), the very marked similarity of *L. mirabilis* and *Stereum cinerascens* (Schw.) Masee, was noted. Since then the type specimen of *Stereum turgidum* has been seen and is obviously referable to *L. mirabilis*. A detailed comparison of these three species has now been made and is presented below.



Comparison of *Lopharia mirabilis*, *Stereum turgidum* and *Stereum cinerascens*.

(1) Gross morphology of the hymenium.

*Stereum turgidum* is interesting as a close link between extreme forms of *L. mirabilis* and *S. cinerascens*. Its type specimen is effuso-reflexed with a light-coloured hymenium covered with irregular warts, teeth or incised ridges, not very regularly arranged but nevertheless more or less radiating. Part of the hymenium is perfectly smooth, and on other parts there are only a few, minute, scattered tubercles. Most specimens of *S. cinerascens* are quite smooth, and some tend to crack on drying to reveal a silky subiculum. Some others show a feeble development of hymenial papillae. *L. mirabilis* shows either a geometrical or an irregular pattern in the distribution of its papillae, teeth, or incised ridges, and may even bear shallow pores bounded by incised ridges. The hymenium is usually uncracked, but may crack as in *S. cinerascens*.

The possession of incised ridges and crests, or teeth, the chief character of the genus *Lopharia*, is by no means constant.

(2) Tissue distribution.

It was first thought that the distribution of the cystidia in the tissues might provide a constant difference between the three species. Sixteen sections of different collections of the three species were made. Some are illustrated in Fig. 1 to show that intergrading occurs.

FIG. 1. See pg. 345.

Characteristic specimens of *L. mirabilis* tend to be thinner and possess a single stratum of hymenial cystidia mostly projecting above the hymenium, while characteristic *S. cinerascens* tends to be thicker and have deeply embedded cystidia as well as those projecting from the hymenium. Air spaces are common in *S. cinerascens*. Every possible variation between these two extremes is shown in the single piece of the type specimen of *S. turgidum* preserved in Pretoria Herbarium.

As shown in Fig. 1, other characters of tissue distribution are also unreliable as points of difference. Here it should be noted that the tissue indicated as a basal seam subtending the surface hairs, varies in density. It is sometimes almost undifferentiated, but more often forms a narrow or wide, light-coloured zone, with well-defined boundaries.

Measurements of the microscopic features, excluding spores, of *L. mirabilis*, *S. cinerascens* and *S. turgidum*, are summarised in Table 1.

TABLE 1.  
MEASUREMENTS OF MICROSCOPIC CHARACTERS.

	<i>L. mirabilis</i> .	<i>S. cinerascens</i> .	<i>S. turgidum</i> .
Basidia.....	50-65 × 9-11 μ	40-50-(80) × 9-10 μ	45-68 × (5)-9 μ
Cystidia.....	66-130 × 13-21 μ	100-150 × 12-24 μ	50-90-130 × 16-24 μ
Hyphae.....	3-4 μ	3.5-4.4-5 μ	3.4-5 μ
Hairs.....	4 μ	3.5-4.4-5 μ	3.4-5 μ
Thickness in section, excluding hairs and ridges.....	250-300 μ	250-400-800 μ	390-600 μ

The measurements given in Table 1 were made several months apart and without reference to each other. They show some differences, as is to be expected from measuring only a few representatives of each type of organ, but also show a close enough correspondence to be accepted as additional evidence for the identity of the three species.

### (3) Spore size and shape.

Ninety spores of *L. mirabilis* distributed among eleven collections, ninety-one of *S. cinerascens* distributed among eight collections, and fifty of *S. turgidum* from the type collection only, were measured. After the manner of Corner (in *New Phytologist* 46, 1947, 195), a sporograph was plotted from the spore measurements of each species and the result is shown in Fig. 2.

FIG. 2. See pg. 346.

The sporographs indicate that the spores of all three species correspond in shape throughout the stages of their development. The sporograph links, for example, globose spores measuring  $5 \times 5$  micrometer units, with oblong or elliptical ones measuring  $6 \times 12$  micrometer units (Note: 1 micrometer unit =  $1.1 \mu$ ). This suggests that the spores of *Lopharia javanica* (cited as  $5-6 \times 5-7 \mu$ ) may have been immature, and that this species, if apparently different from *L. mirabilis* only in spore characters, may in fact be the same species. That is only supposition, and needs to be tested by reference to the type specimen, which is not available.

Statistical calculations from the spore measurements were made, and are shown in Table 2.

TABLE 2.  
SPORE MEASUREMENTS.

Fungus.	Extreme Range in Microns.	Mean Values in Microns.	Micrometer Units.	
			Mean Length.	Mean Width.
<i>Stereum cinerascens</i> (91 readings on 11 collections)	5.5-14.3 $\times$ 4.4-8.8	10.6 $\times$ 6.1	9.73 S.D. $\pm$ 1.41	5.59 S.D. $\pm$ 0.70
<i>Lopharia mirabilis</i> (90 readings on 8 collections)	5.5-13.2 $\times$ 4.4-7.7	10.7 $\times$ 6.2	9.63 S.D. $\pm$ 1.49	5.54 S.D. $\pm$ 0.88
<i>Stereum turgidum</i> (50 readings on 1 collection)	6.6-14.3 $\times$ 4.4-8.8	11.8 $\times$ 6.2	10.72 S.D. $\pm$ 1.42	5.68 S.D. $\pm$ 0.22

Comparing *S. cinerascens* and *L. mirabilis*:—

Difference in lengths = 0.10 micrometer divisions.

Standard Error of difference =  $\pm$  0.22. Difference insignificant.

Difference in widths = 0.05 micrometer divisions.

Standard Error of difference =  $\pm$  0.12. Difference insignificant.

Comparing *Stereum cinerascens* and *Stereum turgidum*:—

Difference in lengths = 0.99 micrometer divisions.

Standard Error of difference =  $\pm$  0.17. Difference significant.

Difference in Widths = 0.09 micrometer divisions.

Standard Error of difference = 0.21. Difference insignificant.

In these comparisons there is a statistically significant difference only between the lengths of the spores of *S. cinerascens* and *S. turgidum*. It should be remembered that the comparison was made on a series of specimens growing on different substrata and collected and preserved at different stages of development. In the case of *S. cinerascens*, the fact that eleven collections were examined tends to smooth out these differences, but there is no such effect in *S. turgidum* of which only one collection was available. In general these statistics give a useful confirmation of the identity of the three species. For the purposes of mycological taxonomy, and taking into account the variety of conditions under which the fungi grew, a difference in mean length of the spores of only about  $1\ \mu$  is scarcely worth consideration.

The foregoing evidence of macro- and microscopic characters establishes the identity of *L. mirabilis*, *S. turgidum* and *S. cinerascens* as a single variable species, for which the specific epithet *cinerascens* has priority. To decide the genus in which this species should be placed, it is necessary to consider the types of the genera *Lopharia* and *Stereum*.

### Typification of the genera *Stereum* and *Lopharia*.

The genus *Stereum* Pers. ex S. F. Gray is accepted as validly published without conservation (Rogers in Farlowia 3, 1949, 450). An acceptable type species for the genus has already been selected by Rogers (in Farlowia 3, 1949, pp. 450, 480) and independently by Donk (in Bull. Bot. Gard. Buitenzorg, ser. iii, 18, 1949, 98-99), from among the five species first listed by S. F. Gray (in A Natural Arrangement of British Plants 1, 1821, 652). This species is *Stereum hirsutum*, an eminently reasonable selection which preserves the name *Stereum* in its present sense and conforms to the Rules of Nomenclature.

*Lopharia* was erected as a monotypic genus with the species *L. lirelloso*, which is thus the type species. This species, as has been shown, is synonymous with *L. mirabilis*, but even if it were possible to point out specific differences these would not materially affect the subsequent discussion on the status of the genus.

The type species of the genus *Lopharia* possesses the internal structure and tissue distribution characteristic of the type species of the genus *Stereum*, except for the presence of cystidia in the former. As we do not recognise cystidia as of generic significance in *Stereum*, and, taking into account the demonstrable variability of the hymenium in *Lopharia*, there remains no bar to reducing *Lopharia* to synonymy with *Stereum*. The correct name for the species represented by the morphological forms known as *Radulum mirabile* (1873), *Thelephora cinerascens* (1832), and *Stereum turgidum* (1916), is *Stereum cinerascens* (Schw.) Masee. This species may be considered as the type species of the genus *Lloydella* Bres., being the first species listed under that genus by Bresadola (in Lloyd Myc. Writ. 1, 1901, 51), and conforming to the author's description of that genus. However, we do not recognise the genus *Lloydella*, which differs from *Stereum* only in the possession of cystidia.

By combining the nomenclators given for *Lopharia mirabilis* in this paper, and for *Stereum cinerascens* in a previous paper (Talbot, loc. cit.) a rather full synonymy is obtained for *Stereum cinerascens*, in which the writer has examined the type or authentic material for all the following species: *Stereum cinerascens* (Schw.) Masee, *Corticium aschistum* Berk. & Curt., *Peniophora berkeleyi* Cooke, *Stereum moricola* Berk., *Stereum dissitum* Berk., *Corticium ephebium* Berk. & Curt., *Peniophora occidentalis* Ellis & Everh., *Lopharia mirabilis* (B. & Br.) Pat., *Lopharia lirellosa* Kalchbr. & MacOwan, *Stereum caperatum* Lloyd, *Stereum turgidum* Lloyd.

### Other species of *Lopharia*.

Two other species of *Lopharia* have been described. The first, *L. javanica* P. Henn. & E. Nym. (in Monsunia 1, 1889, 144), is said by Petch (loc. cit) to appear to differ from



*L. mirabilis* only in the size of its spores. It is suggested earlier in this paper that if this is really the only difference, then the sporograph may be used to relate the two species.

The last species of *Lopharia* to be described was *L. dregeana* (Berk.) Talbot, which the writer transferred from *Corticium* (Talbot, loc. cit.), and at the time expressed doubt in the choice of genus. As the genus *Lopharia* has now been shown to be untenable, it is necessary to reconsider *L. dregeana*. That combination was made in good faith, but too hastily, for the writer has now discovered that *Irpex vellereus* Berk. & Br. (!) is conspecific with the irpicoid forms of *L. dregeana* which he noted earlier. Here then is another group of species, all with identical microscopic characters but varying in the convolution of the hymenium. The hymenial variations intergrade and cannot be accepted as constituting specific differences. The group is composed of *Corticium dregeanum* Berk. (!) having a smooth hymenium except for a few, small, scattered tubercles, *Lopharia dregeana* (Berk.) Talbot in which the former species was associated with further specimens bearing a lopharioid hymenium, and *Irpex vellereus* Berk. & Br., with irpicoid, flattened teeth coalesced at the base or containing specimens with longer, discrete, hydroid teeth.

*Irpex lacteus* Fr. was chosen as the lectotype species of the genus *Irpex* Fries, by Clements & Shear (The Genera of Fungi, 1931, p. 346), from among the species first described by Fries (Elenchus Fung. 1, 1828, 142-148). Reasons for this choice were not given, but as it is thought to preserve the name *Irpex* in its present usage, it is adopted here. With the genus thus typified it is clear that *Irpex vellereus* has been correctly classified as to genus, but as the specific epithet *dregeanum* has priority the new combination *Irpex dregeanus* (Berk.) Talbot is necessary. The synonymy of this species is set out below.

***Irpex dregeanus* (Berk.) Talbot *comb. nov.***

*Corticium dregeanum* Berkeley (!) in Hooker's Lond. Journ. Bot. 5 (1846) 3; Saccardo, Syll. Fung. 6 (1888) 636; Montagne in Ann. Sci. Nat. ser. iii, 7 (1847) 174.

*Hymenochaete dregeana* (Berk.) Massee in Journ. Linn. Soc. Bot. 27 (1890) 114.

*Lopharia dregeana* (Berk.) Talbot in Bothalia 6 (1951) 57.

*Irpex vellereus* Berk. & Br. (!) in Journ. Linn. Soc. Bot. 14 (1873) 61; Saccardo, Syll. Fung. 6 (1888) 489; van der Byl in Ann. Univ. Stellenbosch 12 (1934) 4, figs. 5-6.

The author is much indebted to Dr. R. W. G. Dennis of Kew Herbarium, to Dr. D. P. Rogers, and to the Director and Staff of the Commonwealth Mycological Herbarium, for illuminating discussions of some problems in nomenclature.

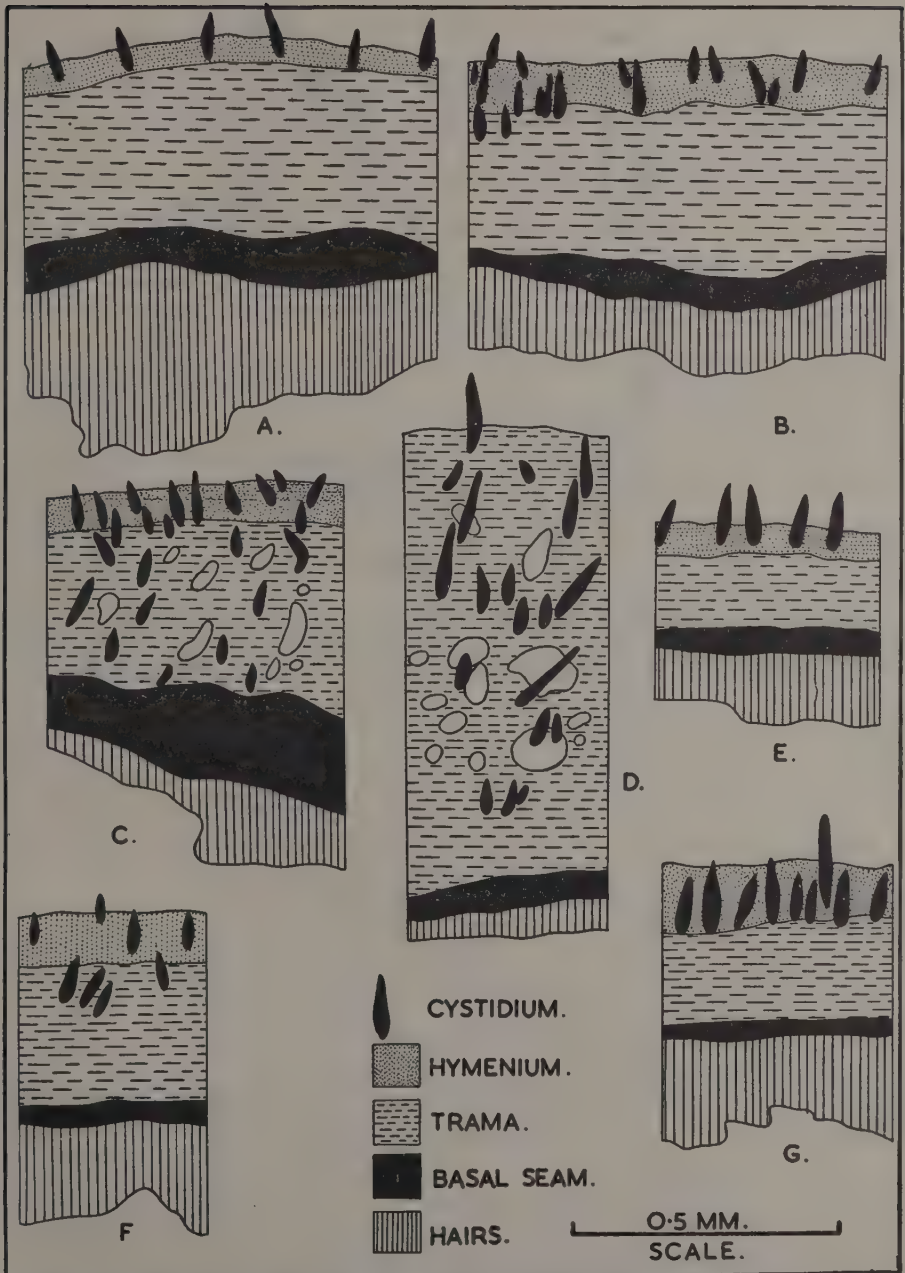


FIG. 1.—Sections of the fructifications of *Stereum turgidum* (A, B, C), *Stereum cinerascens* (D, F) and *Lopharia mirabilis* (E, G), drawn diagrammatically with the aid of a camera lucida to show variation and intergrading of internal characters, and also to show the distribution of the tissues.

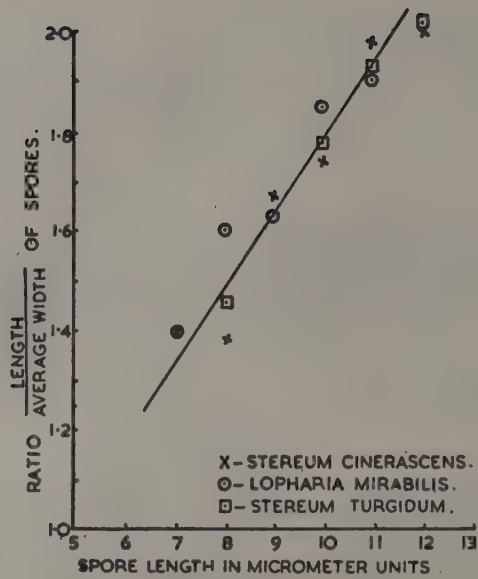


FIG. 2.—Sporographs of *Stereum cinerascens*, *Lopharia mirabilis* and *Stereum turgidum*, relating the length of the spores to the ratio length/average width of spores. Points determined by less than five readings are not shown on the graph.



## Some Graminicolous Species of *Helminthosporium* and *Curvularia* Occurring in South Africa.

By

K. M. Putterill.

The form-genus *Helminthosporium* is so broadly defined that it has accommodated many types of dematiaceous fungi possessing phragmospores, despite fundamental differences they may have shown. Since its foundation in 1809, the genus has become an unwieldy and heterogeneous collection of species, out of which a number of smaller genera need to be formed as natural groupings become apparent. *Curvularia* is another form-genus, recently split from *Helminthosporium*, but even in this comparatively small group there may be no true relationship between species, since their perfect states are still unknown.

*Cylindro-Helminthosporium*, a subgenus discussed later, appears to show more affinities among its species than merely a common characteristic conidial form. Several of its species also produce a *Pyrenophora* stage, indicating close relationship throughout their life-cycle, which is the only true criterion of affinity. Similarly the species of *Eu-Helminthosporium* are conidial states of the ascomycete genus *Cochliobolus*.

In the present paper, twenty species distributed in *Helminthosporium* and *Curvularia* are described. Most are new records for South Africa; some are previously undescribed species. The perfect states of these conidial forms have not yet been seriously sought in this country, but are recorded elsewhere for some of these species. The descriptions given here are based primarily on South African material.

Not the least of the taxonomic problems concerned in this study was that of determining the generic limits of *Helminthosporium*. For example in species such as *H. miyakei* (see p. 367), the conidia are strongly tapering and unlike those found in *Eu-* or *Cylindro-Helminthosporium*, but rather approaching the form of *Cercospora* conidia. Chupp gives evidence that species such as *Cercospora phaeocarpa* Mitter (56, p. 239) with thick-walled conidia might be better classified under *Helminthosporium*, but such species differ in several important features from typical *Helminthosporia*. *C. phaeocarpa* possesses a stromatic base, the upper cells of which form one-celled conidiophores about 6–15  $\mu$  long. The development of conidiophores on a pseudoparenchymatous foundation is not a feature ordinarily associated with *Helminthosporium*, which typically produces separate or only basally fused conidiophores each as a several-celled branch of a basal hypha. Obviously, dealing with form-genera, there must be borderline cases and intergrading between genera, each setting its individual problem for the taxonomist.

Collections in the National Herbarium, Pretoria, include a number of *Helminthosporium* forms parasitic on species of *Meliola*, and not typical of either *Eu-* or *Cylindro-Helminthosporium*. They have been described by Hansford (21).

The conidial forms present numerous other problems connected with their great variability in nature and in culture. First is the fact that many are collective species consisting of several strains differing from one another in morphological or physiological detail, but forming a continuous series within specific limits. The protean nature of *H. sativum*, for example, has become so apparent with intensive study that systematists have had to define the species in more and more elastic terms. This has

had the unfortunate result that other *Helminthosporia* associated with foot-rots are often overlooked. Important parasites have been studied most, and are thus known to have several strains; the tendency to regard newer or little-known species as more rigid is quite unjustifiable. The policy adopted in this paper has been to use existing names rather than tentative new ones, for experience has shown that the full range of a species may not be covered in the first description. *H. leersii* (see p. 365) is cited as an example of this conservative treatment.

In nature, as well as in artificial culture, new forms constantly arise by saltation. In culture different strains may even be obtained from a single conidium. Some species are more prone to saltation than others, and there are certain conditions not necessarily identical for all species, which will predispose a fungus to behave thus. The literature on *H. gramineum*, *H. sativum* and *H. sacchari* (q.v.) deals extensively with controlled experiments to study conditions inducing saltation.

Related to the phenomenon of saltation are those of staling and deterioration in culture. Some species are much more unstable than others under conditions generally found suitable for the maintenance of *Helminthosporia* in the laboratory. Species presenting the greatest difficulty are those which appear in insufficient quantity on the natural substratum, yet deteriorate so rapidly in culture under standard conditions, that it is impossible to continue obtaining characteristic samples. *H. bicolor* and *H. rostratum*, in particular, soon resulted in cultural forms so different from the original as to lead to conflicting identifications discussed under these titles.

The fact that various strains of a species may differ from one another in physiological behaviour or pathogenicity is most important in phytopathology. As host varieties may also differ in susceptibility to fungal attack, much caution is necessary in drawing conclusions from varietal resistance tests.

The possibility of attack by more than one fungus at a time requires mention. In association with other parasites, a weakly pathogenic strain may accomplish what it could not do alone, or mixed strains may inhibit the growth of one another. Mixed associations have been encountered repeatedly in the course of this study, and are discussed under the heading of *H. sativum* and other foot-rotting species.

Though this paper is not primarily concerned with the disease aspect, yet any account of species of *Helminthosporium* would be incomplete without reference to their relationship to their hosts. This aspect is dealt with under each species, and references to phytopathological literature are given. Disease symptoms are characteristic only within certain limits; eye-spot, stripe, foot-rot, etc., are symptoms which may be produced by several different species. Symptoms attributed to many species described in this paper are uncertain, often because of the presence of other fungi. The need for further investigation in view of the incompleteness of such descriptions is stressed.

Host differences are an aid in the distinction of species of *Helminthosporium*, but are not completely reliable. Although many *Helminthosporium* species are very similar each must stand on its own morphological characteristics; too often species have been described as "new" because they were found on previously unrecorded hosts. *H. halodes* is a case in point. Here there might have seemed ample reason for prejudice against using, for a form from foot-rotted wheat, a name given to a species from so different a substratum as *Distichlis spicata* (L.) Greene, growing in a salt-marsh subject to occasional inundation by sea water.

In this study, prune agar, Brown's standard agar, and autoclaved host tissues were the media used. Cultures were incubated at 25° C. Every species received in living condition was studied in pure culture as well as on the host. Measurements of conidia and other structures were taken from frequency charts compiled from at least one sample from each medium, and more where obtainable from the host. Up to 100 spores were measured in a sample, depending on the variability of the spore population.

My thanks are due to Mr. E. W. Mason of the Commonwealth Mycological Institute at Kew, Dr. Johanna Westerdijk of the Centraalbureau voor Schimmelcultures at Baarn, and Dr. Mitra of the Agricultural Research Institute at Pusa, India, for confirming my identifications of three of the species and for naming two others dealt with here.

### Natural Subdivisions of *Helminthosporium*, and Associated Ascigerous Forms.

Mention has been made in the Introduction of natural groups within the large form-genus *Helminthosporium*. It will be convenient to examine in this section all available reports of ascigerous stages connected with *Helminthosporium* species, none of which have been known to develop the "perfect" state in South Africa. The reason for this may be that under our milder winter conditions there is no need for the fungus to pass into the more resistant sexual state; the conidia, especially thick-walled ones, are sufficiently resistant themselves. Alternatively *Helminthosporia* from cereal crops may be maintained between seasons on secondary wild grass hosts, or even on self-sown seedlings of the crop itself. This is known to happen in coastal and other districts where the winter is mildest.

Sometimes the mere beginnings of a perithecial body are laid down; there are many records of "immature perithecia", "immature sclerotia" and "sclerotial bodies". In culture, many species develop thick "knots" or mycelial complexes containing abundant anastomoses. Similar sclerotial growths occur naturally. But even if perithecia should be formed, and asci within them, it is well known that if suitable conditions intervene before the ascospores are mature, then further development of these spores may be suspended in favour of the immediate formation of conidiophores and conidia, even from the surface of the perithecium. Thus the influence of climate or environment on the life-cycle is profound, and it is partly this fact that has caused our understanding of the complete life-cycles of these fungi to develop so slowly.

Species of *Helminthosporium* are the conidial stages of some *Pyrenomycetes*. In the fact that they do not all pass into the same ascigerous form we have the most striking corroboration of the belief that *Helminthosporium* is a large composite genus, presently to be split up into more natural groups. A start has now been made. In 1929, Nisikado (43) proposed the division of *Helminthosporium* into two subgenera. He based his work on Drechsler's (15) observation that the conidial shapes and modes of germination fall into two main groups, and that this division corresponds with the possession of *Ophiobolus* or *Pyrenophora* perithecial stages so far as these are known. Thus Nisikado's *Eu-Helminthosporium* possesses fusiform conidia germinating from the poles only, together with an *Ophiobolus* stage; *Cylindro-Helminthosporium* is characterised by cylindrical conidia germinating from intermediate as well as polar cells, and by a *Pyrenophora* stage. Not all the species of *Helminthosporium* studied by Nisikado have yet been linked with a perithecial stage; but a glance at the summary below will show that if any one can be satisfactorily classified on conidial characters, its ascomycetous stage may be predicted with fair certainty.

With the heterogeneous nature of *Helminthosporium* thus exposed, the need for a special generic name under which to describe the full life-cycle of a fungus such as *H. teres*—*Pyrenophora teres* becomes insistent. That need was not met by Ito (28) when, in 1930, he raised Nisikado's *Cylindro-Helminthosporium* to generic rank under the name *Drechslera*, for apparently the term was to refer only to the conidial stage. In 1930, *Pyrenophora* was no more precise in meaning than *Helminthosporium*, thus Ito could have chosen to break away from both old generic names and describe the full life-cycle under a new genus of *Ascomycetes*. The genus *Pyrenophora* Fuckel became confused when Saccardo incorporated into it various non-sclerotiid forms previously known as species of *Chaetoplea*. However, in 1934, Drechsler (19) ably surveyed the field and pointed out that "through the elevation of *Chaetoplea* to generic



rank by Clements & Shear (7), *Pyrenophora* is automatically rehabilitated as a natural genus in the sense defined and applied by Fuckel, being reserved for the hard, sclerotoid perithecial forms having their asexual stages in *Helminthosporium*-forms such as *H. teres*, *H. bromi*, *H. tritici-repentis* with indiscriminate germination, and corresponding broadly with Nisikado's subgenus *Cylindro-Helminthosporium* and Ito's genus *Drechslera*". And further, "to this sense it would seem to be highly desirable that further usage and application should rigorously conform".

Species of *Pyrenophora* included by the authors discussed above comprise the following:—

*P. phaeocomes* (Reb.) Sacc. (19; 49, vol. 11). Type species.

*P. relicina* (Fuckel) Sacc.

*P. teres* Drechsl. (14, 19, 60). Connected with *H. teres*.

*P. bromi* (Died.) Drechsl. (14, 19). Connected with *H. bromi*.

*P. tritici-repentis* (Died.) Drechsl. (14, 19). Connected with *H. tritici-repentis*.

*P. graminea* Ito (28). Connected with *H. gramineum*.

*P. avenae*. Connected with *H. avenae*.

*P. japonica* Ito (28).

*P. polytricha* da Camara (9). Connected with *H. olisiponense*.

Forms possibly connected with the same series: *P. chaetomioides* Speg. (49, Vol. 16). Said to be connected with *H. penicillosum* Speg.

Forms not yet connected with *Pyrenophora*, but named by Ito as species of the genus *Drechslera* (28): *D. arundinis* (*H. arundinis*); *D. catenaria* (*H. catenarium*); *D. gigantea* (*H. giganteum*); *D. tritici-vulgaris* (*H. tritici-vulgaris*).

Forms connected with the same series by Drechsler: *H. erythrospilum* Drechsl. (19 a); *H. dictioides* Drechsl. (19 a); *H. siccans* Drechsl. (19 a); *H. vagans* Drechsl. (18).

The present use of the name *Pyrenophora* in preference to *Pleospora* of so many authors requires comment. *Pyrenophora* was erected in 1849 and *Pleospora* eight years later. Fuckel restricted the genus *Pyrenophora* to forms with hard sclerotoid perithecia. Saccardo, however (49, v. 11) distinguished *Pyrenophora* as "*Pleospora*, but with setose perithecia". The latter simple distinction has been generally adopted, though some authors, notably Winter, considered the possession of setae insufficient reason for the maintenance of a separate genus. Drechsler (19) discusses the point and concludes that "excessive emphasis on the presence or absence of setose outgrowths as a criterion for distinguishing *Pyrenophora* and *Pleospora* has obscured much more important differences in life-histories and structure". The type species of *Pleospora*, *P. herbarum* (Pers.) Rab., is associated with a *Macrosporium* conidial stage, while the restricted group of species referred definitely to *Pyrenophora* by Fuckel have all been associated with *Helminthosporium*. Stripped of non-sclerotoid forms, and distinguished also from *Pleospora*, Fuckel's genus *Pyrenophora* now stands out as a natural one. Under this name, therefore, we leave *Cylindro-Helminthosporium* Nisikado.

Turning now to *Eu-Helminthosporium* Nisikado, it is clear that a similar need exists here for a name which will indicate the occurrence of both *Helminthosporium* and *Ophiobolus* stages in this combination only. Drechsler has shown that the majority of species in the collective genus *Ophiobolus* are not connected with a *Helminthosporium* stage at all, but instead with a *Phoma* type of asexual stage. Further, those that do have a *Helminthosporium* stage agree among themselves (and differ from other *Ophiobolus* species) in having a pronounced helicoid arrangement of the ascospores within the ascus, and consequently unusually long ascospores and wide asci. The mutual relationship of forms with *Eu-Helminthosporium*—*Ophiobolus* life-cycles being

without doubt natural, the group may be removed from both genera and established independently. For these species, Drechsler (19) erected the new genus *Cochliobolus*.

So far the genus *Cochliobolus* includes the following species:—

*C. heterostrophus* Drechsl. (19) type species. Synonyms *Ophiobolus heterostrophus* Drechsl. (15, 16) and *Helminthosporium maydis* Nisikado & Miyake (44).

*C. sativus* (Ito & Kuribayashi) Drechsl. (31, 19). Connected with *H. sativum*.

*C. kusanoi* (Nisikado) Drechsl. (42). Connected with *H. kusanoi*.

*C. miyabeanus* (Ito & Kuribayashi) Drechsl. (29). Connected with *H. oryzae*.

*C. setariae* (Ito) Drechsl. (28). Connected with *H. setariae*.

*C. stenospilus* (Carpenter) Drechsl. Connected with *H. stenospilum*.

It is clear that the conidial stages of *Pyrenophora* and *Cochliobolus* account for a large number of the known graminicolous species of *Helminthosporium*, but there still remain other species from grasses that cannot be assigned to either genus, and these will now be considered.

*H. dematioideum*, which germinates by production of germ-tubes from the basal cell, is one of these. Another may be *H. miyakei* with conidia of unique form. There are also the species parasitic on *Meliola* in which the conidial shape is also different.

*H. giganteum* Heald & Wolf (17), produces a whorl of germ-tubes at each end of the conidium. In addition to producing normal conidia, it sporulates abundantly in a manner like *Hormodendrum*. A sexual stage has not yet been found, but these two features alone are enough to show that the affinities of this species lie in another direction.

Then there is the relationship between *H. sigmoideum* Cáv. and *Leptosphaeria salvinii* Catt., demonstrated by Tullis (58). *H. sigmoideum* is unusual in having conidia with rather pointed, differently coloured end cells, and the sharp pointed "sterigmata" of the conidiophores are unique. Finally it produces the well-known sclerotial stage, *Sclerotium oryzae*, which is commoner than the conidial stage itself. Examination of the genus *Leptosphaeria* appears to justify the suspicion that *L. salvinii* is misplaced in this genus, and that its independence should be recognised by a new generic name. In the literature at her disposal, the author has found no other *Leptosphaeria* having a *Helminthosporium* stage. Several *Leptosphaeria* species have phomaceous conidial stages, while what appears to be the type species of the genus, *L. doliohum* (Pers.) de Not., is stated by Saccardo (49) to have a *Periconia* conidial stage. *Leptosphaeria* as it appears in the *Sylloge Fungorum* is a large assemblage in which smaller groups will certainly prove to be independent natural genera, and the fungus under discussion is probably one. We cannot, however, go further than this interesting speculation until we have seen authentic specimens and examined the work of da Camara (9) on the genus, neither of which is available to us at present.

Finally there is the related series of small-spored species for which Boedijn (2) erected the genus *Curvularia*, under which name they are discussed in this paper. Most of these develop more or less cylindrical stromata, but apparently perithecia have not yet been reported for any of them.

#### Species of *Helminthosporium* found in South Africa.

(1) *Helminthosporium teres* Saccardo, in Fung. Italici (1881) t. 833, Sacc. Syll. Fung. 4 (1886) 412.

*Helminthosporium hordei* Eid. in Der Landwirt, Bd. 27 (1891) 509.

*Illustrations:* FIG. 1.

*Conidia* cylindrical, straight or nearly so, usually with a slightly uneven contour, both ends rounded; basal septum often very slightly constricted so that the basal segment is characteristically rounded in outline. Mature conidia, especially when beginning to germinate, are frequently slightly constricted at the septa; walls thin; colour sub-hyaline or tinted faint smoky yellow-green, to deeper smoky yellow; hilum large, included in basal contour. Conidia  $30\text{--}195 \times 10\text{--}23 \mu$  [over  $200 \mu$  long and with 1–11 septa fide Smith & Rattray (65)], borne on geniculations or swellings of the conidiophores. *Conidiophores* stout, septate, usually simple, yellowish-brown or olivaceous, usually  $80\text{--}230 \times (6)\text{--}7\text{--}9\text{--}(11) \mu$ , wider across the swollen basal cell, emergent from stomata or between epidermal cells in groups of two or occasionally three, possessing large distinct scars left by fallen conidia.

*Ascigerous stage:* *Pyrenophora teres* Drechs. Cultures of *H. teres* are characterised by abundant anastomoses and the consequent formation of small, round black sclerotia in large numbers. Sclerotial bodies form naturally on dead plants during autumn and if conditions are suitable, give rise to perithecia in the spring. Diedicke (11) originally suggested the name *Pleospora teres* for the perithecial stage, though perithecia had not then been found. The complete ascigerous stage was first described by Drechsler (14) under *Pyrenophora* and in view of the fact that Diedicke's fungus was purely hypothetical, Wakefield & Moore (60) have observed that the correct citation of the species is *Pyrenophora teres* Drechs.

Drechsler (14) states that conidia of *H. teres* always have a slight constriction of the basal septum so that the basal segment is characteristically rounded. Smith & Rattray (53) have not found this feature constant in South African specimens; the present writer finds the feature well represented, if not quite constant in all specimens examined. In South Africa, the conidia seem to reach somewhat larger dimensions than those recorded elsewhere.

*H. teres* Saccardo (1881) was later described by its author in terms which make it impossible to be distinguished from either of the two other species of *Helminthosporium* common on barley. Ravn (47) taking into account differences in destructiveness, distinguished the then known leaf-stripe disease (which he attributed to *H. gramineum*) from what he called Helminthosporiosis (i.e. "net-blotch") of barley. To the fungus causing the latter, he applied Saccardo's binomial, *H. teres*, an opinion later confirmed by Saccardo himself. Further comment differentiating these species will be found under *H. gramineum*.

Specimens examined: F. 693, on *Hordeum*, Pretoria, 6/10/09; 8411, W. Fletcher, on *Hordeum vulgare*, Elim, 20/10/14; 21787, Krieger Schädliche Pilze Exsicc., on *Hordeum distichum*, Europe; 25884, N. J. G. Smith, on *Hordeum*, Belmont Valley, Albany, 1929; 25885, N. J. G. Smith, on *Hordeum*, Grahamstown, June 1930; 25886, N. J. G. Smith, on *Hordeum*, Swellendam, July 1930; 25887, N. J. G. Smith, on *Hordeum*, Swellendam, 7/7/30; 30377, J. Sellschop, on *Hordeum vulgare*, Louis Trichardt, Sept., 1938; 30855 and 30856, J. Sellschop, on *Hordeum*, Louis Trichardt, Aug., 1939.

Pathological notes: *H. teres* causes "net-blotch" of barley, which, though common, is not so serious as leaf-stripe caused by *H. gramineum*. In primary infections the seed-borne fungus may infect the first leaf, as found with *H. gramineum*, resulting similarly in a pale stripe, which may turn brown. Severely infected young plants may closely resemble those suffering from leaf-stripe disease. The later leaves are not ordinarily infected by contact, so that the stripe form of the disease is rarely seen after the seedling stage. Instead, conidia blown from primary lesions cause secondary infections of the foliage, and the irregular blotches thus produced are by far the commonest symptoms to be seen. Typically these blotches or streaks are smallish, reticulate patches of narrow dark brown lines over a lighter background, and usually surrounded by a yellowish border. Very elongated lesions may resemble the stripes caused by *H. gramineum*, though their placing is more haphazard. The grain is similarly



contaminated by windblown conidia, but though secondary infections may reach epidemic proportions they rarely reduce the yield seriously. Ascospores maturing in spring cause infections of the secondary type.

"Net-blotch" is common wherever barley is grown. Because of the conditions necessary for secondary infections, it is most prevalent in damp places or seasons. Perithecia have not yet been recorded in South Africa. In this country it is not even necessary for the fungus to be seed-borne, for wherever the climate is suitable it may live on self-sown plants, or plant remains, all the year round.

(2) *Helminthosporium gramineum* Rabenhorst, Herb. Myc. No. 332 (1856); Saccardo, Syll. Fung. 10 (1892) 615.

*Brachysporium gracile* (Wallr.) Sacc. var. *gramineum* Rabenh., Sacc. Syll. Fung. 4 (1886) 430.

*Napicladium hordei* Rostrup, Sygdomme landbr. for. Snyl. (1893) 130-132.

*Illustrations:* FIG. 2.

*Conidia* nearly always straight, typically cylindrical, often somewhat narrower in the upper half, broadly rounded at each end, the hilum included in the basal contour, subhyaline to yellowish-brown; walls fairly thin; rarely slightly constricted at the septa. *Conidia* measure  $20-120 \times 11-22 \mu$ , with 1-7-(8) septa. *Germination* from polar and intermediate segments. Smaller secondary spores are frequently formed on short processes from germinating primary conidia. In isolates containing secondary spores, these and the smaller primary spores are indistinguishable, so that the range of spore size is extended at the lower end. The larger spores in an isolate are thus to be regarded as more characteristic of the species and more important in its identification.

*Conidiophores:* light yellowish-brown, lighter in the upper part, simple, septate, bearing successive conidia on moderate-sized geniculations leaving distinct scars after separation. *Conidiophores*  $30-200 \mu$  long, and  $5-9 \mu$  wide above the swollen basal cell; arising singly or in groups of 2-6 from stomata or between epidermal cells.

*Ascigerous stage:* *Pyrenophora graminea* Ito. Diedicke (10, 11) reported an ascigerous stage of *H. gramineum*, referring it to *Pleospora trichostoma* (Fr.) Wint. He regarded this as a collective species and later split it up, naming the form from barley *P. graminea*. Drechsler (14) considered that the fungus thus described by Diedicke was actually the perfect stage of *H. teres*. Ito & Kuribayshi (30) agreed with Drechsler's conclusion. Although Drechsler mentioned that Paxton had found the mature perithecial stage of *H. gramineum* neither of these workers described the fungus. Ito (28) first published a description of *Pyrenophora graminea* as a new species.

*H. gramineum* was one of the first parasitic graminicolous *Helminthosporia* to be described but it was many years before it was clearly distinguished from other species of *Helminthosporium* on the same host. Ravn (47) first differentiated *H. gramineum* and *H. teres* and correctly observed the disease symptoms attributable to each. In 1910 a third parasite of barley, *H. sativum*, was described by Pammel, King & Bakke. Early descriptions of *H. gramineum* and barley leaf-stripe are therefore confused.

Ravn pointed out that microscopically the conidia and conidiophores of *H. teres* and *H. gramineum* are hardly distinguishable from one another. The writer has found that Drechsler's distinctions (14), though useful, do not invariably hold good. It was found that "typical" conidia of *H. gramineum* attained a greater maximum length and breadth than recorded by Drechsler and others, and may have up to 8 septa, while the conidiophores were not markedly narrower than those of *H. teres*. As Smith (53) states: "the two are best distinguished from one another by the commonness of spores in *H. teres* samples which are superior in length to any conidia developed by the other species". *H. sativum* is easily distinguished microscopically from the above two species, by its conidia.

Specimens examined: 21785, 21786, *Krieger: Schädliche Pilzen*, on *Hordeum vulgare*; 25888, *N. J. G. Smith*, on *Hordeum*, Grahamstown, 27/6/30; 25889, *N. J. G. Smith*, on *Hordeum*, Aylesbury, Albany, C.P., Aug. 1929; 30861, 30862, *J. Sellschop*, on *Hordeum*, Branddraai, Lydenburg, Tvl., Sept. 1939.

Pathological notes: *H. gramineum* causes leaf-stripe disease of barley, which is one of the most widespread and destructive maladies of this crop, especially in colder climates. Many workers in colder countries have claimed that infected plants cannot recover. In South Africa the disease does not ordinarily cause great losses, for conditions are such that the host plant is able to outstrip the parasite. Smith has described leaf-stripe very fully, both in its typical form (50) and as it occurs in South Africa (53).

Leaf-stripe is most easily recognised if the manner of formation of the strip is clearly understood. The disease is seed-borne, and Smith (50, 53) has shown that the fungus does not grow up with the plant by maintaining itself in a smut-like fashion in the growing point, as Ravn (47, 48) claimed. Instead the coleoptile becomes infected by the seed-borne fungus and transfers its infection to the first small enclosed leaf, which, as it grows itself enwraps and so infects the second young leaf. Each successive leaf, and finally the young ear, become infected in turn from its wrapping. As the elongating leaves and sheaths brush past the source of infection continuous vertical strips become infected and show the typical stripe. At first the stripes are yellow but later turn brown. The leaves may split along the stripes. The development of a typically striped plant depends on the relative growth rates of the host and parasite. A vigorous plant which outstrips the fungus may show only a partially developed form of the disease. If the fungus reaches the ear it may prevent normal seed formation, while if it invades growing points the plant may be killed before maturity, as happens in severe outbreaks of the disease.

It is evident that symptoms of this disease may be confused with elongated secondary lesions caused by *H. teres* or *H. sativum*. In these latter species, however, the lesions are caused by wind-blown conidia and are usually entirely haphazard. Wind-blown conidia of *H. gramineum* do not seriously affect plants during the growing season.

Under certain conditions *H. gramineum* has been known to cause foot-rot of barley. It has also been isolated from wheat, oats and maize.

### (3) *Helminthosporium mediocre* sp. nov.

*Illustration*: FIG. 3 a.

*Conidia* brownish-yellow,  $40-108 \times 13-18 \mu$ , with 2-10 septa, sub-cylindrical or long elliptical, usually straight, sometimes slightly curved, widest in the middle or slightly below it, narrowing somewhat towards the ends both of which are broadly and similarly rounded; walls of medium thickness, hilum included in the basal contour. *Germination* bipolar.

*Conidiophores*: light olive-brown,  $80-150 \mu$  long and  $5.5-8 \mu$  wide, usually with a swollen basal cell; emerging singly from the epidermis.

*Ascigerous stage*: unknown.

*Helminthosporium mediocre* sp. nov.

*Conidia*: flavo-fusca,  $40-108 \times 13-18 \mu$ , 2-10 septatis, subcylindrica vel longe ellipsoidea, crassitudo maxima ad vel paullo infra medio, fere recta, interdum leviter curvata, plerumque attenuata, ad basin et apicem late et similiter rotundata; membranae mediocres, hilum in extrema basalis inclusum. *Germinatio* bipolaris. *Conidiophora*: pallide olivacea,  $80-150 \mu$  longis et  $5.5-8 \mu$  latis; cellulis basalis fere incrassatis, ex epidermi singulariter emergens. *Typus* No. 30756.

*H. mediocre*, both in culture and on the host plant, is devoid of any extraordinary distinguishing feature. No record of any similar species of *Helminthosporium* on *Pennisetum* could be traced. A portion of the type was sent to the Commonwealth Mycological Institute but no name for it could be suggested.

*H. leucostylum* Drechsl. and *H. nodulosum* B. & C. have been found capable of attacking *Pennisetum typhoideum* under experimental conditions (39), but both of these differ from *H. mediocre* in the size and shape of their conidia. Other records of species of *Helminthosporium* on *Pennisetum* occur in phytopathological literature, but none were found to include a description of the fungus.

In culture on prune agar, the conidia (Fig. 3 b) were found to be smaller, darker, with thicker walls and with the end cells often somewhat lighter. The end cells were sometimes emphasised. The conidia measured only  $33\text{--}82 \times 12\text{--}15 \mu$ . The conidiophores appeared longer in culture as they merged gradually into long, narrow hyphae below.

Specimens examined: 30756, L. C. C. Liebenberg, on *Pennisetum clandestinum*, Schagen, Tvl., June, 1939.

Pathological notes: The fungus occurred on discoloured basal sheaths and leaf blades of *Pennisetum clandestinum* in numerous brown spots about 0.2–1.5 mm.  $\times$  1–2 mm., or larger by coalescence. The spots were slightly elongated lengthwise. As other fungi were also growing in these lesions, and no inoculation tests were made, it is not known whether this species was parasitic.

(4) *Helminthosporium sativum* Pammel, King & Bakke in Iowa Agr. Expt. Sta. Bull. 116 (1910) 178–190; Saccardo Syll. Fung. 25 (1931) 822.

*Helminthosporium acrothecioides* Lindfors. Svensk. Bot. Tidskr. 12 (1918) 227.

Illustrations: Figs. 4a & 4 b.

*Conidia*: Long-elliptical, widest near the middle, tapering towards the rounded ends, typically slightly or distinctly curved, greenish or brownish-olivaceous when mature, often opaque, lighter at the ends,  $26\text{--}120 \times 12\text{--}26 \mu$ , with 3–10 septa; wall thick, thinning towards the ends; hilum well marked. *Germination* bipolar.

*Conidiophores*: Erect, simple, septate,  $6\text{--}8 \mu$  wide,  $60\text{--}300 \mu$  long, olivaceous, paler at the apex; arising from dead host tissue from between epidermal cells or stomata, either singly or in groups of 2–4, bearing about 6 conidia. Variable in culture, sometimes branching irregularly and bearing many conidia.

*Ascigerous stage*: *Cochliobolus sativus* (Ito & Kuribayashi) Drechsl. (19).

The perfect stage of this fungus was unknown until 1929, when it was described by Kuribayashi (31) as *Ophiobolus sativus*.

*Helminthosporium sativum* was first described (Pammel *et al.* loc. cit.) from barley. Its presence undoubtedly caused a great deal of confusion in descriptions of other congeneric cereal parasites before that date.

*H. sativum* is most difficult to define satisfactorily. Its astonishing variability in morphology and parasitic behaviour has been extensively studied by many workers (6, 14, 37). The species has been found to comprise many races, which, though morphologically inseparable, differ greatly in pathogenicity and cultural behaviour. Morphological characters may vary widely under different conditions. New races arise with ease as saltants in culture, and apparently also in nature. The large-spored species of *Helminthosporium*, as Drechsler (20) observes, offer the greatest possibilities for variation in their length and septation with the consequent tendency for such species to be divided into new races or strains.

The writer found that conidia produced in cultures of *H. sativum* differed greatly from those occurring naturally (Fig. 4 b). In culture the conidia were often irregularly shaped, bent rather than merely curved, and sometimes showing bifurcate ends. Many were scarcely longer than wide, and had none or few septa, which were often irregularly



spaced or set at odd angles. Conidia formed on greenhouse plants, and occasionally under natural conditions, tended to show the same peculiarities. It is thus hardly possible to define a typical conidium, but we may assume that the most typical are those from cultures.

Specimens examined: 25890, *N. J. G. Smith*, on *Hordeum*, Grahamstown, 27/6/30; 30421, *J. Pons*, on *Triticum vulgare*, Lydenburg, Tvl., 17/10/38; 30493, *J. Sellschop*, on *Triticum vulgare*, Bethlehem, Nov. 1938; 30857, 30858, 30859, *J. Sellschop*, on *Hordeum*, Louis Trichardt, 10/8/39; 30860, *J. Sellschop*, on *Hordeum*, Lydenburg, Tvl., Sept. 1939; 30990, 30991, *J. Pons*, on *Triticum vulgare*, Lydenburg, Tvl., Oct. 1939.

Pathological notes: *H. sativum* is parasitic on barley, wheat, rye and other cereals and wild grasses, on which it causes more than one type of damage. It appears to be world-wide in distribution (6, 13, 14, 22, 24-27, 33, 36, 37, 38, 40, 53, 54). It is especially severe on wheat and barley in the United States. In South Africa it is common on both wheat and barley, and has also been isolated from oats and wild grasses.

The nature and severity of the disease symptoms vary with the mode of infection, environment, strain of the fungus and the host concerned. This variability is noticed even on a single host. Strains from different hosts have been found to be interchangeable. The types of damage described below occurred on barley and wheat, but though a set of experiments with a single strain cannot be typical of all cases, it applies roughly throughout the host range.

The fungus may be carried in the grain, where, for example, it causes "black point" of wheat. In such cases, if germination is not prevented, seedling blight may result. Plants which survive or escape this may be attacked by root- or foot-rot caused by the same fungus. Such plants display marked discolouration round the base and sometimes a bronzing of the foliage. Similar rots may be caused in plants from clean seed by conidia that have lodged in the soil. Severely affected plants die or are dwarfed, and may be prevented from tillering. If infection is less severe, or the host plant withstands the infection, the parasite may actually stimulate the plant to excessive tillering. The heads, if formed, rarely fill properly, and the grain may be shrivelled.

*H. sativum* may also cause a disease known as "spot-blotch". Here, conidia formed on the diseased parts cause secondary infections of the later foliage or stems in the form of small spots or blotches. These are up to 10 mm. long, or longer on the stems, at first yellow but later turning brown with or without a yellowish margin. The ears and grain may also be infected by the conidia. Where the foliage is much reduced by disease, the grain usually ripens prematurely if it is formed at all.

Though it has been found (e.g. Mitra & Bose, 38) that the optimum conditions for damage are plentiful moisture and warmth this result may be misleading. Plants weakened by drought may fall prey to parasites which they might otherwise have resisted. Foot-rot occurs in dry as well as in moist areas. Mourashkinsky (40), working on the control of cereal diseases in arid districts in Russia, states that seedling wilts of cereals, caused by *H. sativum* and other species of *Helminthosporium* and *Fusarium*, are of some importance in dry regions. He finds it erroneous to believe that drought is so unfavourable for disease development that control measures may be relaxed. The longevity of the thick-walled conidia of *H. sativum*, together with its ability to grow saprophytically on dead or dying tissue of the Gramineae, makes this fungus difficult to control.

South African conditions are seldom such as to encourage the development of serious disease from secondary infections. The writer's experience has been that although the "spot-blotch" form of the disease is common in the summer-rainfall areas, the foot-rot form is much more destructive.

Examination of numerous plants affected by foot-rot in different parts of the country has shown that *H. sativum* occurs commonly in company with a fairly constant set of other fungi. These fungi have been isolated from the bases of many living plants

showing foot-rot, but not from dead material. Species of *Fusarium* (especially *F. avenaceum*) and *Curvularia* (e.g. *C. spicifera*) were the most constant and important associates. Other fungi that were isolated more than once were: *H. bicolor* Mitra, *H. halodes* var. *tritici* Mitra, *H. rostratum* Drechsler, and *H. dematioideum*. As many as seven such associates were isolated on one occasion from a single plant which was not particularly reduced. Sometimes *H. bicolor* or *H. halodes* was associated with a *Fusarium* and/or a *Curvularia* on plants attacked by foot-rot, though *H. sativum* was not present. No doubt there are other fungi which may participate.

In the writer's opinion, foot-rot of wheat in South Africa is very often attributable to the combined action of a complex of fungi, rather than to *H. sativum* alone. If so it would explain why *H. sativum* isolated from foot-rot specimens often proves to be feebly parasitic on re-inoculation. But the tendency of this species to produce saltants in culture should not be overlooked. The point can only be established by a series of experimental inoculations of these fungi singly and in combinations. Hynes (24, 26), in Australia, has undertaken just such a series of experiments. He found damage to be greatest when plants were inoculated simultaneously with *H. sativum*, *Fusarium culmorum* and *Curvularia ramosa*—a remarkably close parallel with what the writer has found in South Africa. Hynes did not, however, find in Australia all the large-spored species of *Helminthosporium* named in the present paper, though most of these have been associated with foot-rot elsewhere. Hynes concluded that "the large-spored species of *Helminthosporium* associated with foot-rot throughout Australia is predominantly, if not exclusively, *H. sativum*". This conclusion does not find support in South Africa.

(5) *Helminthosporium* N Henry in Minn. Agr. Expt. Sta. Tech. Bull. 22 (1924).

*Illustrations:* FIG. 5.

*Conidia:* Long-elliptical, widest near the middle, tapering somewhat towards the rounded ends, slightly or distinctly curved, sometimes straight; wall fairly thick, thinner towards the ends; hilum well-marked, not protruding, but flat rather than included in the rounded basal contour; conidia fuliginous or greyish-olivaceous, lighter at the ends,  $16\text{--}82 \times 8\text{--}16.5 \mu$ , with 1–10 septa. *Germination* bipolar.

*Conidiophores:* variable, often branching below the conidium-bearing part, geniculate, up to  $7 \mu$  wide. Only seen in culture.

*Ascigerous stage:* unknown.

This species has conidia very similar to those of *H. sativum*, but rather more uniform in shape. The most pronounced difference is in the width of the conidia, although differences in length and colour are also apparent. Henry (22, p. 35) gives a table comparing variations and constants for the conidia of the two species. Both he and Drechsler considered *Helminthosporium* N sufficiently distinct from *H. sativum* to be regarded as a new species but neither named it specifically. Both noted a resemblance in the spores of *Podosporiella verticillata* O'Gara (45).

Specimens examined: 30497, J. Sehschop, on *Triticum vulgare*, Bethlehem, Nov. 1938.

*Pathological notes:* *Helminthosporium* N was originally reported on wheat, where it produced symptoms similar to those caused by *H. sativum*. It was, however, less virulent. It is probably more common than it appears from the records, being very liable to be identified as one of the many variants of *H. sativum*.

The South African isolation was made from the culm bases of wheat attacked by foot-rot. No inoculation experiments were done, so its relationship to the host and to other foot-rotting fungi present remains in doubt.

(6) *Helminthosporium bicolor* Mitra in Trans. Brit. Myc. Soc. 15 (1930) 286.*Illustrations:* FIG. 6.

*Conidia:* roughly cylindrical with bluntly rounded ends, or long-elliptical and widest near the middle then narrowing towards the rounded ends, straight or slightly curved; wall thick, thinning towards the end segments; hilum included in the basal contour or occasionally showing slightly outside; olivaceous-brown or yellowish- to smoky-brown to dark brown, sometimes opaque, paler in the end segments;  $20\text{--}90\text{--}(108) \times 8\text{--}18 \mu$ ; septa 1-12, the terminal septa thicker and darker. *Germination* bipolar.

*Conidiophores:* brownish, variable in culture, from  $160 \mu$  long; the short fertile region markedly geniculate, sometimes forked,  $5\text{--}7 \mu$  wide, narrower below; conidia borne at short intervals on the geniculations.

*Ascigerous stage:* unknown.

All the South African isolates of this taxonomic species agree well with the description of *H. bicolor* Mitra, except that the majority of their conidia are longer and have marked end-septa. In view of this discrepancy, two isolates (Nos. 30496, 30432) were sent to Dr. Mitra, who confirmed their identity as *H. bicolor*, but noted that accentuated septa are not shown in the type. In these two strains isolated from Wheat and sorghum respectively, and from different localities, conidia up to  $108 \mu$  in length occurred. The maximum length in other South African isolates was  $75\text{--}90 \mu$ , and  $79 \mu$  in the type specimen. These unusually long conidia were slender, sometimes distinctly curved, and much lighter in colour (see three conidia figured at top of Fig. 6) than the usual conidia for this species. They occurred only in the fresh specimens and in the first culture isolations from fresh material, but by means of monospore cultures it was proved that subcultures from the long conidia later produced only average conidia. The two extremes thus belonged to the same species, which showed many intermediate forms in culture. In addition, examination of standing conidiophores in culture showed that the first-formed conidia were of the long, light-coloured type, and that the shorter, darker conidia were formed later and more abundantly.

Cultures of this species were among the most rapidly staling of any encountered in this study (cfr. introduction), and staling was apparently accompanied by a decrease in the size of the conidia. Measurements of conidia in staling cultures of No. 30496 agreed well with those for *H. euchlaenae* Zimm. In the description of the latter there is no mention of emphasised terminal septa or lighter end cells. While it is possible that *H. bicolor* and *H. euchlaenae* are synonymous this point requires further investigation, and at present the South African material is better disposed under *H. bicolor*. A summary of measurements relevant to this discussion is given in Table 1, below.

TABLE 1.

Fungus.	Measurements of Conidia in $\mu$ .	No. of Septa.	Authority.
<i>H. euchlaenae</i> Zimm.....	$50\text{--}60 \times 13\text{--}15$	7	Saccardo, Syll. Fung. 18, p. 592.
<i>H. euchlaenae</i> strain Sideris, Hawaii	$32\text{--}62 \times 11\text{--}14$	5-7	C.B.S., Baarn, in litt.
<i>H. bicolor</i> Mitra.....	$16\cdot5\text{--}79 \times 10\text{--}20$	1-9	Mitra.
No. 30496 (fresh).....	$20\text{--}108 \times 8\text{--}16$	3-11	} Present studies.
No. 30496 (staling).....	$44\text{--}63 \times 12\cdot7\text{--}15$	5-7	
No. 30432.....	$20\text{--}105 \times 10\text{--}17$	1-12	
No. 30458.....	$13\text{--}75 \times 10\text{--}18$	2-9	



Specimens examined: 30432, *L. Codd*, on *Sorghum halipense*, Pretoria; 30458, *J. Sellschop*, on *Triticum*, Clarens, O.F.S., Nov. 1938; 30496, *J. Sellschop*, on *Triticum*, Bethlehem, Nov. 1938.

Pathological notes: *H. bicolor* was described as the cause of foot-rot and root-rot of barley and wheat seedlings in India. In South Africa it has been isolated from wheat showing foot-rot, grown in various parts of the country. This fungus has also been found associated with lesions surrounded by dull-red borders, on leaves of *Sorghum halipense* and *S. verticilliflorum*. In some cases *Helminthosporium turcicum* was also present.

(7) **Helminthosporium halodes** Drechsler in Journ. Agric. Res. 24 (1923) 707.

*Illustration:* FIG. 7.

*Conidia* long-elliptical, straight or slightly curved, widest at or above the middle, narrowing somewhat towards the broadly-rounded apex and more markedly towards the narrowly-rounded or roughly triangular basal cell; walls fairly thick, becoming thinner towards the ends; hilum protruding, large, conspicuous; septa 1-11, the terminal septa thick and dark; colour greenish- or yellowish-brown to dark or smoky-brown, lighter in the end segments;  $20-85 \times 10-21 \mu$ . *Germination* bipolar. *Conidiophores* (in culture) simple, usually long,  $5-8 \mu$  wide in the enlarged fertile region.

*Ascigerous stage:* unknown.

The above description is based on material in culture. It is evidently identical with *H. halodes* Drechsler var. *tritici* Mitra (36, p. 287), which Dr. Mitra himself kindly confirmed. The variety differs from Drechsler's species in spore size and septation. Mitra gives the extreme spore measurements as  $23-73 \times 13-20 \mu$ , with 2-9 septa, while the extreme measurements for Drechsler's type are  $20-105 \times 10-14 \mu$  with 1-12 septa. In length and septation the conidia of the South African strain thus fall between the two, and the conidia may attain a slightly greater width than Mitra claimed.

The present description, like Mitra's, was based on cultures obtained from foot-rotted wheat, and no naturally occurring conidia were seen. Drechsler found that *H. halodes* showed a tendency towards the production of shorter, thicker and darker conidia in culture. This is a variation towards the form shown in *H. halodes* var. *tritici*, and it is thus not improbable that the latter is an ill-founded variety. In view of the known cultural irregularities and abnormalities of *H. halodes*, as striking as those found in *H. sativum*, the author would minimise the seemingly important difference in the width of the conidia and dispose her material under *H. halodes* rather than under the variety *tritici*.

Specimens examined: 30434, *K. M. Putterill*, on *Triticum*, Brits, Oct., 1938.

Pathological notes: *H. halodes* was originally described on *Distichlis spicata* in the United States of America. The symptoms it produced resembled those caused by *H. sativum*. It has been reported as a parasite of sugar-cane seedlings, maize, sorghum, wheat and barley in India (55). The variety *tritici* associated with foot-rot of wheat in India (Mitra, 36) was found to infect barley seedlings as well. In South Africa, *H. halodes* was isolated from foot-rotted wheat.

(8) **Helminthosporium rostratum** Drechsler in Journ. Agric. Res. 24 (1923) 722.

*Illustrations:* FIG. 8.

*Conidia* long-elliptical, straight or slightly curved, widest near the middle, with a broadly rounded to subconical base; apex broadly rounded in the shorter conidia but narrowing markedly in the longer conidia, often elongated into a rostrate extension; walls thick, thinning towards the ends; hilum large and strongly protruding; septa 3-21 (usually more than 10), the terminal septa usually accentuated except the apical septum in rostrate conidia; greenish-yellow when young, olivaceous- or yellowish-brown, dark olivaceous or blackish-brown at maturity, more dilutely coloured in the end

segments and with a very light area round the hilum and the extreme apex;  $20-180 \times 10-26 \mu$ , usually  $13-20 \mu$  wide. Germination bipolar. Conidiophores (in culture) variable, simple,  $160 \mu$  long, or longer, the fertile region expanded,  $6-9 \mu$  wide, geniculate, olivaceous.

*Ascigerous stage:* unknown.

Both isolations made of this fungus showed extreme conidial variation in culture. Drechsler (loc. cit.) states, "on artificial media, the fungus produces conidiophores bearing conidia altogether similar to those found in nature". In the author's material, rostrate conidia agreeing well with *H. rostratum* were produced in the first set of cultures, but appeared less readily in the second set and were absent from subsequent cultures. In being half their original length and tending to become obovate in the shortest conidia, the later conidia strongly resembled those of *H. halodes*. In a private communication Dr. Westerdijk confirmed the author's identification of No. 30456 as "*H. rostratum* Drechs. with typical rostrate conidia", but within two months on subcultures the same fungus, still in pure culture, was indistinguishable from *H. halodes* Mitra, a fact which Dr. Mitra kindly confirmed. In view of these facts and the variability of this fungus in culture, which is paralleled by the cultural behaviour of *H. sativum* and *H. bicolor*, the South African isolations are best assigned to *H. rostratum*.

Specimens examined: 30456, *J. Sellschop*, on *Triticum*, Bethlehem, Nov. 1938; 30460, *J. Sellschop*, on *Triticum*, Ferraira, Nov. 1938.

Pathological notes: *Helminthosporium rostratum* was described (loc. cit.) from the dry leaves of *Eragrostis major* in the U.S.A. Its author stated, "the mature condition of the grass precluded any inquiry into the biological relation of the fungus to its substratum".

The South African isolations were made from the base of wheat plants affected by foot-rot. One isolate (No. 30456) was found in association with *H. sativum*, *H. bicolor*, *Helminthosporium N*, *Curvularia spicifera*, *Curvularia* sp., and *Fusarium avenaceum*. Five of these fungi have been found on grasses affected by foot-rot. The second isolate was associated with *H. sativum*, *H. dematioideum*, *Fusarium* sp. (probably *F. avenaceum*) and *Curvularia* sp. No inoculations were made to test the ability of *H. rostratum* to cause foot-rot alone.

(9) *Helminthosporium turcicum* Passerini in Bol. Comiz. Agr. Parmense 10 (1876); Saccardo Syll. Fung. 4 (1886) 420.

*Helminthosporium inconspicuum* Cooke & Ellis in Grevillea 6 (1878) 88.

*Illustrations:* FIG. 9.

Conidia long elliptical, straight, less often slightly curved; broadest near the middle and narrowing decidedly towards the ends; apex rounded; basal cell conical, often more rounded; thin-walled; hilum prominent, characteristically protruding. Septa 1-8-(11). Subhyaline with a grey-green tint, to light yellow-brown.  $50-140-(154) \times 15-26 \mu$ . Germination bipolar. Conidiophores simple, few-septate, fertile region moderately geniculate, light olivaceous;  $100-280 \times 7-10 \mu$ ; emerging in small groups from the stomata.

*Ascigerous stage:* unknown.

Specimens examined: F. 890, *H. G. Mundy*, on *Zea mays*, Rhodesia, Feb. 1910; 1134 *May Varney*, on *Sorghum vulgare*, Kansas, U.S.A., Oct. 1889; 7913, *Briosi & Cavara* on *Zea mays*, Pavia, Italy, 1889; 2187 *J. Fisher*, on *Zea mays*, Cedara, Natal, March 1912; 9729, *Angus & Co.*, on *Sorghum verticilliflorum*, Dalton, Natal, March 1916; 10099, *J. Pope-Ellis*, on *Sorghum halipense*, Ashburton, Natal, April 1919; 15448, *Th. Eruleben*, on *Sorghum sudanense*, Pietermaritzburg, March 1922; 15462,

*R. R. Staples*, on *S. sudanense*, Cedara, Apr. 1922; 20354, *Entomologist*, on *Zea mays*, Belgian Congo, March 1935; 20386, *McKay*, on *Zea mays*, Naboomspruit, Apr. 1935; 28600, *L. C. C. Liebenberg*, on *S. halipense*, Prinshof, Pretoria, March 1936; 30431, 30432, *K. M. Putterill*, on *S. halipense*, Prinshof, Pretoria, Dec. 1938; 30708, *K. M. Putterill*, on *Sorghum verticilliflorum*, Prinshof, Pretoria, Jan. 1939; 30709, *K. M. Putterill*, on *S. sudanense*, Prinshof, Pretoria; 30710, *K. M. Putterill*, on *S. halipense*, Prinshof, Pretoria, Jan. 1939.

Pathological notes: *Helminthosporium turcicum* is the cause of leaf blight or "white-blast" of maize, a conspicuous and often serious disease. It occurs in all maize-growing countries. The same disease has also been described on various species of *Sorghum*.

In South Africa, Doidge & Bottomley (12) found that leaf blight "causes considerable damage (to maize) in Natal in wet seasons, but appears to have slight ill effects elsewhere". In the summers of 1937-39 entire plantings of *Sorghum sudanense* at Prinshof, Pretoria, were rendered useless by the disease. In Rhodesia (23), and Madagascar it completely destroyed maize crops, especially of newly introduced varieties, while it is regarded as important enough in Kenya to justify extensive work on the breeding of resistant varieties.

The symptoms of this disease are evident as small straw-coloured lesions, often surrounded by a darker outline, which may later merge into one large blotch covering almost the entire surface. Fully grown plants are not usually much affected, but where the infection occurs early in the wet season on young plants, the destruction of large leaf-areas with considerable subsequent damage to the crop, may result. On species of *Sorghum* the symptoms resemble those on maize, except that the smaller lesions have reddish-brown borders, or may consist of yellowish blotches turning reddish or blackish later.

Elsewhere *H. turcicum* has been found capable of infecting barley, oats, rice, sugar-cane and wheat, under experimental conditions. Although various workers have found the strains on these hosts interchangeable, it is suspected that the strains from maize and *Sorghum* may be biologically different.

Drechsler (15) believes that leaf blight caused by *H. turcicum* may often have masked the simultaneous appearance of leafspot caused by *Cochliobolus heterostrophus* (*H. maydis* Nisi. & Miyake) on maize plants. This latter fungus would otherwise have been more widely known in maize areas. It has not yet been recorded in South Africa.

(10) *Helminthosporium leucostylum* Drechsler in Journ. Agric. Res. 24 (1923) 710.

*Illustrations*: FIG. 10.

*Conidia* usually straight, widest about one-third from the base, tapering evenly and characteristically towards the narrow apex; base paraboloid or sometimes broadly rounded; wall thick, thinning in the terminal cells to conspicuous thin areas at the extreme apices and around the hilum which is conspicuous but not protruding; medium to dark olivaceous, or olive-brown, lighter in the terminal cells; 1-8 septate, not constricted at the septa;  $15-80 \times 8-17 \mu$ . Germination bipolar. *Conidiophores* simple, very short, the fertile region markedly geniculate, the tip somewhat flattened; typically subhyaline to light fuliginous, darkening lower down;  $25-105 \times 5-6.5 \mu$ ; emerging in groups from the stomata. Well-spaced conidia leave prominent scars on separation from the conidiophores.

*Ascigerous stage*: unknown.

Drechsler named this species *leucostylum* because of the characteristic colourless or light-fuliginous conidiophores. According to his description and figures, the conidiophores are as light at the base as at the apex. Drechsler's figures show the conidiophores to be of even thickness throughout, and rounded at the top. The conidiophores in South African material differed somewhat in being subhyaline at



the apex but deeper in colour towards the base. The most typical conidiophores were fairly light fuliginous, but others (e.g. in No. 23689) were not much lighter in colour than the olive-brown conidia.

Mitra & Mehta (39) described an isolate from *Eleusine coracana* which differed from the type in having slightly larger, olive-brown conidia and conidiophores which were "conspicuously slender at the basal part, gradually becoming broader at the top which is flat or anvil-shaped". These features are not mentioned by Drechsler, but they agree well with what was seen in South African material.

There is a noticeable variation in the conidiophores in recorded isolations of *H. leucostylum*, but conidial features have remained characteristic. Taking this into consideration, and despite the fact that *H. leucostylum* was named for the lack of coloration in the conidiophores, the South African material is too typical to be assigned to any other species.

Specimens examined: 23689, *P. Cazelet*, on *Eleusine indica*, White River, Tvl., Jan. 1929; 25908, *L. Doidge*, on *Eleusine indica*, Ladysmith, Natal, March 1931; 10036, *L. C. Turner*, on *E. indica*, Vereeniging, Feb. 1917.

Pathological notes: Drechsler (loc. cit.) in describing *H. leucostylum* from *Eleusine indica*, also found it common on *Eragrostis major* in the U.S.A. It has been reported, too, on *E. coracana* in India and Uganda, and on *E. aegyptiaca* in India. It was found in India (39) to be capable of infecting maize, sorghum, *Panicum frumentaceum* and *Pennisetum typhoideum*. On *E. coracana* and *E. aegyptiaca* it is stated to cause leaf-blight or leaf-spot, seedling-blight and head-blight.

In South Africa this species was recorded on *Eleusine indica* by Smith & Putterill (52), who stated that diseased plants were "characterised by a black-dusted withering of the extremities". Tips of inflorescence branches showed empty, discoloured spikelets; tips of leaves withered and tended to split lengthwise, while the lower parts were green and apparently healthy. Black, dusty stripes parallel to the veins on the brown, withered parts resulted from abundant spore formation. Wind-blown conidia may also cause a brown-spotting of the lower parts of the older green leaves. Seedling plants may be killed by this fungus.

Drechsler described similar symptoms on *Eleusine indica*, though their significance was obscured by a considerable overgrowth of other fungi.

(11) *Helminthosporium cynodontis* Marignoni in Micromiceti di Schio (1909); Saccardo Syll. Fung. 22 (1913) 394.

*Illustrations*: FIG. 11.

*Conidia* usually long-elliptical, slightly curved, often straight, widest near the middle and tapering gradually to the rounded ends; wall fairly thin; hilum included in the basal contour; subhyaline to light fuliginous;  $20-83 \times 8-15 \mu$ , with 3-11 septa. *Germination* bipolar. *Conidiophores* simple, dark brown,  $60-200 \times 4-6.5 \mu$ , arising from stomata or between epidermal cells singly or in pairs.

*Ascigerous stage*: unknown.

The South African material agrees well with that from America dealt with by Drechsler (14).

Specimens examined: 27359, *R. Gardner*, on *Cynodon dactylon*, Pilgrims Rest, Feb. 1934; 29976, *B. Wilson*, on *C. bradleyi*, Redan, March 1938; 30242, *A. M. Bottomley*, on *C. bradleyi*, Pretoria, March 1939.

Pathological notes: The type of *H. cynodontis* occurred on dry leaves of *Cynodon dactylon* in Italy. The species has also been recorded by Drechsler (14) in the U.S.A. on *Cynodon dactylon* and *Eleusine indica*, on *C. dactylon* in Kenya (41) and on *C. dactylon* in South Africa (51). The author has found it to be fairly common on *C. dactylon* and *C. bradleyi* in the Transvaal, and on *C. dactylon* in the Eastern Cape

Province. Drechsler also regarded this fungus as common, so that lack of records probably indicates a comparative unimportance of the hosts rather than rarity of the fungus.

The author has found this fungus on dark brown lesions on living leaves and stems, but it is most plentiful on dying or withered parts. In wet seasons, during February and March it was abundant on lawns turning brown and in brown patches on lawns. Species of *Curvularia*, *Rhizoctonia* and also *Helminthosporium dematioideum* have sometimes been found on the same plants with *H. cynodontis*. Although the relationship of the last-named to the host has not been determined it appears to be often secondary to some other agent (e.g. nematodes or *Rhizoctonia*) only becoming conspicuous in unusually wet weather.

(12) *Helminthosporium brizae* Nisikado in Berichte Ohara Inst. für Landw. Forsch. 4 (1929) 122.

*Illustrations:* FIG. 12.

*Conidia* subcylindrical or long-elliptical, straight, only exceptionally curved, widest near the middle, tapering gently towards the abruptly rounded ends; hilum large, conspicuous, included in the basal contour; walls fairly thin, thinner over the ends; subhyaline or light fuliginous at first, later becoming yellowish or yellow-brown, lighter in the basal or both end cells;  $26-75 \times 9.5-15 \mu$ , with 2-7 septa. *Conidiophores* simple, light to dark brown or olivaceous, lighter above;  $40-150 \times 4.5-7.5 \mu$  above the bulbous basal cell; emerging from between epidermal cells singly or in groups of 2-3.

*Ascigerous stage:* unknown.

In Nisikado's description of *H. brizae*, some discrepancies are evident. Although he described the conidia as "usually sub-cylindrical, but widest at a point near the middle and tapering towards both ends", his illustrations are of conidia mostly widest below the middle while tapering decidedly more towards the apex than the base. Because of the lack of material for comparison, the writer decided to accept Nisikado's description rather than his figures.

The South African material differed from the description in only two respects. Firstly, Nisikado made no mention of a rather noticeable hilum. Then, the conidia in the author's material had a shorter average length ( $40 \mu$  instead of  $55 \mu$ ) than the Japanese material, although the range in conidial length was the same in both instances. Conidia were not plentiful in the South African material though abundant conidiophores were present. It seems possible, therefore, that most of the riper, heavier spores had been lost, leaving behind an unrepresentative spore population. Despite these differences there is a good general agreement between the South African material and Nisikado's description of *H. brizae*.

Specimens examined: 28530, K. M. Putterill, on *Briza maxima*, Port Elizabeth, Oct. 1935.

Pathological notes: *H. brizae* was described from the leaves of *Briza minor* in Japan. On this host it was found to cause rectangular or elliptical lesions at first 2-3 mm.  $\times$  1-2 mm. with a scaled appearance, later bleached and up to 10-20 mm.  $\times$  3-5 mm. in size, the leaf at last shrivelling up. The host in South Africa, *Briza maxima*, showed small purplish-black spots on the leaf blades and sheaths. The larger oblong or elliptical lesions, 1-5 mm.  $\times$  0.5-2 mm., each had a minute bleached spot in the centre. There is thus a difference in the symptoms on *Briza maxima* in South Africa and *B. minor* in Japan. Whether this difference is significant is unknown as the host and conditions may determine the appearance of the disease as much as the parasite does.

(13) *Helminthosporium sacchari* (Breda de Haan) Butler in Mem. Dept. Agric. India Bot. ser. 6 (1913) 204–208, Pl. 6; Saccardo Syll. Fung. 25 (1931) 823.

*Cercospora sacchari* Breda de Haan in Meded. Proefsta. Suikerriet West-Java 3 (1892) 15–21.

*Helminthosporium ocellum* Faris in Phytopathology 18 (1928) 753–773.

*Illustrations:* FIG. 13.

*Conidia* long-elliptical or elliptic-fusiform, with a slight or marked crescentic curve, or sometimes straight, widest at the middle tapering slightly to each rounded end; walls thin; hilum included in the basal contour; yellowish or sub-hyaline with a faint smoky greenish to smoky olivaceous-brown tint;  $(33)–50–105–(125) \times 11.5–17–(18) \mu$ , with 3–11 septa. *Germination* bipolar. *Conidiophores* medium smoky olive-brown colour, lighter at the tips, frequently swollen at the base, with geniculate fertile regions, showing distinct conidial scars;  $100–260 \times 4–10 \mu$ ; arising from brown mycelium on the surface of the leaf or below it.

*Ascigerous stage:* unknown.

The causal organism of eye-spot disease of sugarcane was first described (3) as *Cercospora sacchari* under which name it was later recorded from many other sugarcane-growing areas. Butler (4) noted that the fungus was better classified in *Helminthosporium*, and made the transfer. Van der Byl (59) recorded *Cercospora sacchari* from Natal, but also noted that it was more properly a *Helminthosporium*. Faris (20) claimed that in Cuba the eye-spot fungus of de Haan and others differed from Butler's *H. sacchari*, and distinguished the former as *Helminthosporium ocellum* n. sp. Mitra (37) showed that "*H. sacchari* Butler and its saltants have a range of variation in spore dimensions sufficiently wide to include all the forms of *Helminthosporium* causing eye-spot of sugarcane". The same may be said of the range of symptoms on different varieties of cane under different conditions. McRae (34, 35) in reporting Mitra's work, stated, "The conclusion drawn so far is that *H. sacchari* Butler and *H. ocellum* Faris are identical, though they are different strains, and the name *H. sacchari* Butler with its amplified description (Mitra 36, p. 290) should be maintained for the eye-spot disease in Cuba." This is now generally accepted, and *H. sacchari*, like *H. sativum*, is recognised as a species composed of many different strains.

The conidia of the South African strains are large and resemble those of *H. ocellum* as described by Faris.

Specimens examined: 30245, 30988, A. McMartin, on *Saccharum officinarum*, Mt. Edgecombe, July 1939; 32708, on *Pennisetum* sp., Honolulu, Hawaii.

*Pathological notes:* Eye-spot disease of sugarcane, caused by *H. sacchari*, is recognised by lesions of a dull red colour, usually with a light-brownish centre, formed on the leaves. Young lesions are often surrounded by a pale halo. These spots often spread or coalesce into long streaks with or without a definite eye.

The disease occurs in sugar-belts all over the world. In South Africa it has not been serious. It is most prevalent in cool, damp weather.

The frequency of leaf-spotting and the acuteness of the attack vary with the variety of sugarcane. An Indian cane, Co. 419, was badly attacked, the fungus causing a rot of the unfolded leaves and even attacking the stems which dried and became light in weight.

*H. sacchari* has not been found on hosts other than sugarcane in South Africa, but elsewhere has been recorded on Napier grass, *Pennisetum* sp. It has been found capable of infecting wheat and barley under experimental conditions.



(14) *Helminthosporium leersii* Atkinson in Bull. Cornell Univ. (Sci.) 3 (1897) 47; Saccardo Syll. Fung. 14 (1899) 1087.

*Illustrations:* FIG. 14.

*Conidia* curved, occasionally straight, widest at or just below the middle, tapering evenly towards the rounded ends; walls very thin and not constricted at the septa; hilum inconspicuous and included in the basal contour; light fuliginous;  $52-124 \times (13)-16.5-(20) \mu$ , with 2-12 septa. *Germination* bipolar. *Conidiophores* simple, thick-walled, rigid; basal cell swollen; fertile region straight or moderately geniculate; light to medium brown becoming dark brown, lighter near the apex;  $130-375 \times 6.5-8.5-(10) \mu$ ; emerging singly from the host epidermis.

*Ascigerous stage:* unknown.

In Atkinson's description the conidiophores were characterised as "amphigenous, brown, irregularly nodulose or flexuous,  $200-350 \times 4-6 \mu$ ". Drechsler, who noted the peculiar growth of *H. leersii* in culture, illustrated simple, straight conidiophores taken direct from the host. In South Africa the conidiophores are stout and stiff rather than "irregularly nodulose or flexuous". Though Drechsler did not mention the dimensions of the conidiophores, he indicated the size of the conidia as  $50-95 \times 11-14 \mu$ , thus narrower than the average of  $16.5 \mu$  in the South African isolations. The South African form is apparently not exactly the same as the American. There seems to be a significant difference in conidial width, if not in length, for although conidial length may fluctuate considerably in many species of *Helminthosporium*, the width usually remains rather characteristic.

Nisikado's figures for the conidial measurements of the Japanese form of *H. leersii* ( $45-125 \times 12-20 \mu$ ), agree well with the South African form, but no mention was made of conidiophores.

Although the South African fungus agrees very well with the type in general conidial features (shape, colour, unusual thinness of wall) and appears to match *H. leersii*, there is at least a possibility that it is a distinct strain. However, it must be admitted that the comparatively meagre information available on this species might make it appear more limited than it really is. Until proper comparison of material should demonstrate constant differences it is not advisable to add confusion with a new species, and the South African fungus is provisionally referred to *H. leersii*.

In conidial size and general appearance the author's material bears a resemblance to *H. sacchari*, but the former is recognised by the stiff, dark conidiophores.

Specimens examined: 33115, A. P. D. McClean, on *Leersia hexandra*, Nottingham Road, March 1939; 33116, A. P. D. McClean, on *Setaria* sp., Nottingham Road, March 1939.

Pathological notes: *H. leersii* was described from leaves of *Leersia virginica* in the United States of America. Drechsler (14) later redescribed it from the same host. Nisikado (43) recorded it from Japan on *Leersia hexandra*. In South Africa this fungus was collected on *L. hexandra* and *Setaria* sp. at the same time and place.

The symptoms on the two South African grasses are small indefinite brown spots 1-3 mm. long, elliptical or elongated, which later develop into irregular dark brown eye-spots  $8-10 \times 2-3$  mm. in size, with a straw coloured or bleached ashen centre. Lesions occur chiefly on the leaf-blades of both grasses and are less definite in form on *Setaria*. Fructifications are found on these spots and also on the withered lower leaves. The brown and gray eye-spots are exactly like Drechsler's description of those on *L. virginica*.

(15) *Helminthosporium urochloae* sp. nov.

*Illustrations:* FIG. 15 A & B.

*Conidia* usually straight but sometimes with a slight or pronounced crescentic curve, occasionally slightly sigmoid; widest one third to one half the distance from the

base, tapering towards the rounded ends, often more tapered towards the apex; about half the conidia slightly narrowed near the first or second basal septa, these conidia having a characteristically narrowed proximal part; wall thick, thinner at the ends; hilum not projecting; yellow-brown to olive-brown, later opaque; (62)–90–160–(189)  $\times$  (13)–18–(21)  $\mu$ , with 6–16 septa. *Germination* bipolar. *Conidiophores* simple, with swollen basal cell; fertile region slightly geniculate; dark olive-brown or olivaceous at the base, becoming lighter towards the tips which are light coloured or subhyaline; 160–300  $\times$  5–10  $\mu$ ; mostly emerging singly.

*Ascigerous stage*: unknown.

*Helminthosporium urochloae* sp. nov.

*Conidia*: flavo-fusca vel olivacea, deinde opaca, (62)–90–160–(189)  $\times$  (13)–18–(21)  $\mu$ , 6–16 septatis, fere recta sed interdum leviter vel manifeste curvata, nonnunquam leviter sigmoidea (crassitudo maxima  $\frac{1}{2}$ – $\frac{1}{2}$  supra basin), plerumque attenuata (praeipue ad apicem) et rotundata; conidia dimidia pars leviter contracta ad septis basalis primae et secundae, istae septae pars proxima proprie attenuata; membrana crassa, ad extremitatis tenuioris; hilum non eminens. *Germinatio* bipolaris. *Conidiophora*: simplices, cellulis basalis incrassatis; regio fertilis subgeniculata, basin versus obscure olivacea, apicem versus pallidiora, apices pallidis vel subhyalinis, fere singulariter emergens. *Typus* No. 26148.

Some features of *H. urochloae* suggest comparison with *H. oryzae* B. de H. as described by Drechsler (14), which it resembles in the general shape, colour and size of the conidia. *H. urochloae* differs from the latter species in having a large proportion of conidia with characteristically narrowed basal ends and in the absence of a mycelial crust anywhere on the host. Its conidiophores are somewhat wider than those of *H. oryzae* and in the latter branched conidiophores also occur. *H. urochloae* is easily distinguished by its conidial features from other *Helminthosporia* on grasses.

Specimens examined: 26148, V. A. Wager, on *Urochloa helopus*, Barberton, March 1932; 26182, L. C. C. Liebenberg, on *Urochloa helopus*, Nelspruit, March 1932.

*Pathological notes*: *H. urochloae* was found on *Urochloa helopus* in the Transvaal. No inoculations were made but it is suspected that the fungus was parasitic and responsible for an eye-spot disease. The symptoms were very numerous brown to black lesions varying in size from pinpoints to irregular blotches about 2  $\times$  6 mm. or larger, on the leaf blades. Some remain as ill-defined brown stains, but most develop into irregular eye-spots each with a small straw-coloured or dirty white centre, surrounded by a very dark zone. This peripheral zone is lighter towards the outside and may fade off into the surrounding tissue of the leaf. The fungus was plentiful on all affected parts but especially on the lower withered leaves. No other possible parasites were found.

(16) *Helminthosporium ravenelii* Curtis in Amer. Journ. Sci. ser. ii, 6 (1848) 349–353; Saccardo Syll. Fung. 4 (1886) 412.

*Helminthosporium hoffmanni* Berk. & Curt., Intro. to Crypt. Bot. (1857) 298.

*Helminthosporium tonkinense* Karst. & Roum. in Rev. Myc. 12 (1890) 78.

*Helminthosporium crustaceum* P. Henn. in Hedwigia 41 (1902) 147.

*Illustrations*: FIG. 16.

*Conidia* straight or with a slight crescentic or sigmoid curve, widest near the middle, narrowing slightly to either end, often decidedly narrower towards the base; wall thin; hilum inconspicuous and included in the basal contour; light smoky-yellow to smoky brownish-yellow; 25–82  $\times$  12–18  $\mu$  with (1)–3–4–(7) septa. *Germination* bipolar. *Conidiophores* very distinctive, long, much branched, torulose; light fuscous yellow; 550  $\times$  5–11.5  $\mu$ ; arising close together from a velvety basal layer of interwoven hyphae encrusting the affected parts of the host.

*Ascigerous stage:* unknown.

*H. ravenelii* differs from other species in the unusual conidiophores rather than in conidial characters. These torulose, much branched conidiophores, crowded into a compact crust, are very distinct from the usual simpler, separate conidiophores of many other species. Only one other species, *H. miyakei*, studied by the author displayed similar features.

Specimens examined:

On *Sporobolus capensis*: 1453, I. B. Pole Evans, Harden Heights, 11/4/11; 1826, E. M. Doidge, Zoutpansberg, 14/8/11; 2201, T. Parkins, Eshowe, 5/4/12; 6692, E. Baker, Cedara, 15/5/13; 6921, A. Pegler, Kentani, 26/5/13; 9764, I. B. Pole Evans, Tweedie, 4/7/16; 9769, P. v. d. Byl, Illovo, Natal; 10065, A. O. D. Mogg, Tweedie, 13/4/17; 10097, P. J. Pienaar, Nelspruit, 17/4/17; 11643, A. O. D. Mogg, Tweedie; 20371, C. N. Campbell, Mooi River, Apr. 1925; 31783, H. Power, Illovo, 20/5/16.

On *Sporobolus fimbriatus*: 6667, A. Pegler, Kentani, 14/5/13; 23390, A. O. D. Mogg, Balgowan, 3/4/19.

On *Sporobolus pyramidalis*: 13995, F. Eyles, Salisbury, 20/2/19; 26093, L. C. C. Liebenberg, Lydenburg, Apr. 1931; 29835, E. M. Doidge, Donnybrook, 5/9/37.

Pathological notes: *Helminthosporium ravenelii* is the cause of "false smut" of *Sporobolus* spp. in most warm countries where it is widely distributed. In South Africa the commonest host is *S. capensis*. As the popular name of the disease indicates, the inflorescences of the grass are attacked. It appears at first as a velvety, olive or brown coating on the floral parts, and later turns into a dense black crust which often cakes the separate parts together.

This fungus may not be as economically unimportant as is usually stated. Investigators have proved that ravenelin, a metabolic product of the parasite (46) causes cattle poisoning, of which false smut of *Sporobolus* has been suspected in South Africa and elsewhere (32).

(17) *Helminthosporium miyakei* Nisikado in Berichte Ohara Inst. für Landw. Forsch. 4 (1929) 122.

*Illustrations:* FIG. 17.

*Conidia* bent, or with a crescentic or irregular sigmoid curve, sometimes straight, widest just below the middle, tapering suddenly and often irregularly to a narrow apex, narrowing gradually towards the abruptly rounded base; basal cell often out of alignment; immature conidia mostly without a tapering apex, obovate long-elliptic or irregular; wall thin; hilum included in the basal contour; light yellow-fuliginous;  $25\text{--}113 \times 11\cdot5\text{--}18 \mu$ , with (2)–3–5–(8) septa. *Conidiophores* torulose, profusely branched, arising close together from a mat of interwoven hyphae; up to  $260 \times 4\text{--}11\cdot5 \mu$ .

*Ascigerous stage:* unknown.

*H. miyakei* approaches the genus *Cercospora* in the shape of its conidia, but in every feature except conidial shape it is closely allied to *Helminthosporium ravenelii*. The genus *Helminthosporium* seems the most suitable for its disposal at present. Although the conidial shape in *H. miyakei* differs from that of the other species discussed in this paper, it does find a parallel in some of the conidia of *H. rostratum*. Many conidia of the latter however, do not taper, while the tapering of others is never as marked as in *H. miyakei*.

With only the conidial stage known, it seems unlikely that *H. miyakei* will fall into either of the two main groups *Cylindro-* and *Eu-Helminthosporium*. Further work may reveal *H. miyakei* and *H. ravenelii* as members of another group possessing conidia of the *Helminthosporium* type.



Specimens examined: 7761, T. R. Sim, on *Eragrostis curvula*, Pietermaritzburg, 26/4/14.

Pathological notes: *H. miyakei* forms an clavaceous, later black, crustose growth on the inflorescences of its graminaceous hosts, much like *H. ravenelii*. It has been found only once in South Africa but has been recorded as common on *Eragrostis tef* in Western Ethiopia (5). Nisikado described his type from *Eragrostis pilosa* in Japan. No other records of this interesting and distinctive species have been traced.

(18) *Helminthosporium dematioideum* Bubak & Wroblewski in Hedwigia 57 (1916) 337; Saccardo Syll. Fung. 25 (1931) 821.

*Illustrations:* FIG. 18.

*Conidia* straight, oblong-cylindrical, widest near the middle, hardly tapering towards the rounded apex but narrowing decidedly towards the rounded or sub-conical base; walls thin, sometimes somewhat constricted near the basal septum; hilum included in the basal contour; light yellowish-brown; (20)–30–36–(43)  $\times$  (6)–8–10–(13)  $\mu$ , with 3–5–(7) septa. *Germination* basal. *Conidiophores*: Simple, septate, usually swollen at the base; medium brown, paler at the tips; emerging singly or in small groups from the host epidermis; 50–100  $\times$  (3)–4–6–(7)  $\mu$ .

*Ascigerous stage*: unknown.

In his discussion of the American isolates, Drechsler (14) states, "the principal circumstance suggesting a possible lack of identity of the European and American forms, is the recorded occurrence of the former only on the inflorescence of *Anthoxanthum odoratum* while the latter is much more abundant on the foliage". He suggests that this might be due to a poor original specimen. From the writer's experience it would seem that Drechsler attached too much importance to this slight possible difference in substratum. The South African form fits the description of *H. dematioideum* so well that it must be assigned to this species despite its occurrence on hosts different from the type. The strain from wheat was morphologically indistinguishable from the rest. The identity of Nos. 30241 and 30498 was confirmed by Dr. Westerdijk.

In culture it was found that there was a tendency towards greater variation in conidial size (8–50  $\mu$ ), conidial colour (darker and more olivaceous) and longer conidiophores. Such variations were also found in other species of *Helminthosporium*.

It is notable that the mode of germination of conidia in *H. dematioideum* is not typical of either of the two main classes in which most graminicolous *Helminthosporia* fall, namely those connected with *Pyrenophora* or *Cochliobolus* perfect stages.

Specimens examined: 27358, Naudé, on *Cynodon dactylon*, Pretoria; 27359, R. Gardner, on *Cynodon dactylon*, Pilgrims Rest, 8/2/43; 28779, v. d. Merwe, on *Cynodon bradleyi*, Pretoria, 18/12/36; 30241, K. M. Putterill, on *Cynodon bradleyi*, Pretoria, 20/2/39; 30243, K. M. Putterill, on *Cynodon transvaalensis*, Pretoria, 30/4/39; 30250, J. Roderick, on *Cynodon transvaalensis*, Johannesburg, 15/4/39; 30492, J. Sellschop, on *Triticum*, Ferreira, O.F.S., Nov. 1938.

Pathological notes: *H. dematioideum* was described from Galicia on *Anthoxanthum odoratum*; it was later found by Drechsler (who amplified the description, 14, p. 683) on the same host in the United States of America. Drechsler also found it on *Agrostis* spp. often accompanied by fructifications of larger-spored species of *Helminthosporium*.

In South Africa this fungus was found to be common on withering or dead leaves of *Cynodon transvaalensis*, *C. bradleyi* and *C. dactylon*. On *Cynodon* lawns it was frequently found mixed with *Helminthosporium cynodontis*, species of *Curvularia*, and occasionally with *Rhizoctonia*. These fungi are known to be responsible for causing browning of lawns in summer, thus it is not known what part was played by

*H. dematioideum* in producing this condition. Drechsler was similarly unable to decide, from the specimens found, whether *H. dematioideum* was present as a parasite or saprophyte, but he seemed to believe that it was more saprophytic on *Agrostis* and possibly parasitic on *Anthoxanthum*. The relationship of *H. dematioideum* to its *Cynodon* hosts can be established only by inoculation experiments. At present it may be said that the circumstances under which it appears suggest that it may be saprophytic, or a weak parasite capable of attacking plants already weakened by other fungi. This view is supported by the fact that this fungus was unexpectedly isolated from foot-rotted wheat, in company with a number of foot-rotting fungi.

Although there are not many records of this fungus, the writer's experience suggests that it is common.

### Species of *Curvularia* found in South Africa.

The genus *Curvularia* was erected by Boedijn (2) to accommodate a number of small-spored species that had unnaturally been placed in *Helminthosporium*, *Brachysporium*, *Brachycladium* and *Acrothecium*.

Species of *Curvularia* are characterised by unequally-sided or strongly bent conidia, with 3–4 septa. At least one of the central cells is larger and darker than the others. Most species form branched cylindrical stromata in pure culture. These have a black rind, often with white growing points, and are white inside. No perfect stage has yet been found for any *Curvularia* species.

Boedijn divides the genus into three groups:—

(A) Maculans group: characterised by straight or merely asymmetrical, 3-septate conidia, with the two middle cells larger and darker than the end cells. Stromata are never formed in culture.

(B) Lunata group: characterised by 3-septate conidia, more or less strongly bent, with only one of the middle cells enlarged and darker than the end cells. Most species form stromata.

(C) Geniculata group: characterised by 4-septate conidia and forming stromata in culture.

Boedijn noted that the species of *Curvularia* often consisted of several strains showing minor morphological differences. This is well illustrated in the South African isolations of *C. spicifera* in which a strain from *Cynodon* has very much larger conidia than one from wheat. Host differences cannot be regarded as important among these fungi, which may possibly live in the soil.

The species of *Curvularia* described here belong to the Maculans and Lunata groups, but there are doubtless many other species in South Africa.

(19) *Curvularia spicifera* (Bainier) Boedijn in Bull. Jard. Bot. Buitenzorg, ser. iii, 13 (1933) 81.

*Brachycladium spiciferum* Bainier in Bull. Soc. Myc. de Fr. 24 (1908) 81.

*Helminthosporium tetramera* McKinney in U.S.A. Dept. Agr. Bull. 1347 (1925).

### Illustrations: FIG. 19.

*Conidia* oblong or ellipsoid, straight, with broadly rounded ends; walls fairly thick, thinner towards the ends; hilum protruding slightly outside the basal contour; greenish-fuliginous or brownish, lighter over the ends; (11)–25–35–(43)  $\times$  (7)–9–11–(13)  $\mu$ , with 3 septa, occasionally 2 or 4 septa. *Conidiophores* erect, of variable length; fertile region long and geniculate, olivaceous or brownish, 5–7  $\mu$  diam. Conidia borne freely in long clusters.

*Ascigerous stage*: unknown.

Boedijn placed *C. spicifera* in the Maculans group. Hynes (25) found that McKinney's (33) *Helminthosporium tetramera* was synonymous with *C. spicifera*. However, McKinney reported that his fungus formed stromata in culture, a phenomenon described by Boedijn as specifically non-existent in the Maculans group.

In the writer's material of *C. spicifera* the central cells of the conidia were not as noticeably darker and larger than the end cells as in other material she saw, or as figured by Boedijn. The terminal cells were slightly paler where the wall thinned out over the end cells. Bainier and McKinney did not mention this feature, while Hynes described his conidia as "of a uniform straw brown colour".

Apart from this difference in colour, the strain from *Cynodon* yielded much larger and darker conidia in culture than in nature. In culture the length of the conidia might be up to  $54\ \mu$ , and the diameter up to  $14.5\ \mu$ . This strain was indistinguishable from that on wheat except for conidial size. A culture sent to the Imperial Mycological Institute was identified as "*C. spicifera* except in spore measurements".

Although the South African material differs from the description of the type in some respects, there is a good general agreement between the two. Differences observed and recorded by various workers indicate that this species is composed of a number of strains of varied character.

Specimens examined: 30246, *J. Roderick*, on *Cynodon transvaalensis*, Johannesburg, Apr. 1939; 30494, *J. Sellschop*, on *Triticum* sp., Bethlehem, Nov. 1938.

Pathological notes: *Curvularia spicifera* has been isolated from foot-rotted parts of wheat, oats, barley, rye and rice. Its recorded distribution is The United States of America (8), India (57), Australia (25), Angola (1), and South Africa. The writer has also found it on withering leaves and stems of *Cynodon transvaalensis* in South Africa, occurring among brown patches on lawns of this grass.

*C. spicifera* has so far only been found by the writer in association with other fungi known to be capable of causing foot-rot. Its relationship to its host and its associates is unknown. Neither McKinney nor Hynes regarded it as an important pathogen.

#### (20) *Curvularia* species.

*Illustration:* FIG. 20.

*Conidia* straight or unequal-sided to slightly curved; broadly rounded at the apex and tapering towards the base; base somewhat triangular, squared off in the well-marked hilum; yellowish-brown to brown; 3-septate, with the third cell larger and darker than the others, and with thicker walls; most strongly curved in the third cell;  $(15)\text{--}24\text{--}30\text{--}(36) \times (8)\text{--}10\text{--}14\text{--}(16)\ \mu$ . *Conidiophores* brownish, very variable in length in culture,  $3\text{--}6\ \mu$  diam. in the fertile region. Conidia borne spirally on the geniculate protuberances.

*Ascigerous stage:* unknown.

This species apparently belongs to the Lunata group, with its curved, 3-septate conidia having the third cell from the base larger than the others. But it differs from the Lunata group in that the third cell is not markedly darker than the end cells, and the conidia are seldom strongly bent, often being straight.

A specimen of this fungus was sent to Mr. E. W. Mason, who commented as follows: "It strongly resembles *Brachycladium ramosum* as figured by Bainier [Bull. Soc. Myc. de Fr. 24 (1908) Pl. 4], the only differences being that Bainier said his fungus formed elongated black stromata, covered with conidiophores, and that the conidia were 3 or 4 septate. However, Dr. Boedijn has applied the name *Curvularia ramosa* (Bain.) Boedijn to a distinctly more variable form isolated from wheat in Australia, with longer conidia, 2–5 septate, and with one or more of the central cells often distinctly darker than the two end cells. I would prefer to refer this to *Curvularia lunata* group, at any rate until more is known about the South African species".



The writer has observed white, branched "roots" of fungous tissue growing down into the agar in month-old tube cultures of this species. These structures were probably an arrested stromatic development. Such positively geotropic stromata were seen by Boedijn in cultures of the *Geniculata* group. Especially in old cultures, the conidia sometimes became 4-septate. These septa, which were thinner than the rest and divided the large third cell, were obviously late additions. The addition of further septa in the conidia was one of the variations observed by Boedijn, who found it particularly in the *Lunata* group.

From the above evidence it seems best to follow Mr. Mason's advice and place this species provisionally in the *Lunata* group, until more is known about it.

Specimens examined: 30495, *J. Sellschop*, on *Triticum*, Bethlehem, Nov. 1938.

Pathological notes: This species was isolated from foot-rotted wheat plants in association with other fungi known to be capable of causing foot-rot. No inoculation tests were made. It is possible that the fungus was a secondary invader.

#### LITERATURE CITED.

- (1) BENS AUDE, M..... Comptes Rendus Soc. de Biol. 103 (1930) 1265-1266.
- (2) BOEDIJN, K. B..... Bull. Jard. Bot. Buitenzorg, ser. iii, 13 (1933) 120-134.
- (3) BRED A DE HAAN, J. VAN..... Meded. Proefsta. Suikerriet, West-Java 3 (1892) 15-21.
- (4) BUTLER, E. J. & A. HAFIZ KHAN.. Mem. Dept. Agr. India, Bot. ser. IV (1913) 204-208.
- (5) CASTELLANI, E. & CICC ARONE, A... Reg. Ist. agron. per l'Africa italiana (1939) 32 pp. (Seen Abstract in Rev. Appl. Myc. XIX: 85.)
- (6) CHRISTENSEN, J. J..... Univ. Minn. Agric. Expt. Sta. Tech. Bull. 37 (1926).
- (7) CLEMENTS, F. E. & SHEAR, C. L... The Genera of Fungi (1931).
- (8) CROSIER, W. & WEIMER, D..... Proc. Ass. Off. Seed Anal. N. Amer., 1939. (1940) 120-124. (Seen Abstract in Rev. Appl. Myc. XIX: 601.)
- (9) DA CAMARA, E. DE S..... Rev. Agron 20 (1932) 5-63. (Seen Abstract in Rev. Appl. Myc. XII: 725.)
- (10) DIEDICKE, H..... Centralbl. Bakt. Abt. 11, Bd. 9 (1902) 317-329.
- (11) DIEDICKE, H..... Centralbl. Bakt. Abt. 11, Bd. 11 (1903) 52-59.
- (12) DOIDGE, E. M. & BOTTOMLEY, A. M. Bot. Survey of S. Africa, Mem. No. 11 (1931).
- (13) DOSDALL, L..... Univ. Minn. Agr. Expt. Sta. Tech. Bull. 17 (1923).
- (14) DRECHSLER, C..... Journ. Agric. Res. 24 (1923) 641-740.
- (15) DRECHSLER, C..... Journ. Agric. Res. 31 (1925) 701-726.
- (16) DRECHSLER, C..... Phytopathology 17 (1927) 414.
- (17) DRECHSLER, C..... Journ. Agric. Res. 37 (1928) 473-492.
- (18) DRECHSLER, C..... Journ. Agric. Res. 40 (1930) 447.
- (19) DRECHSLER, C..... Phytopathology, 24 (1934) 953-983.
- (19a) DRECHSLER, C..... Phytopathology 25 (1935) 334-361.
- (20) FARIS, J. A..... Phytopathology 18 (1928) 753-754.
- (21) HANSFORD, C. G..... Imp. Myc. Inst. Mycol. Pap. No. 15 (1946) 213-214.
- (22) HENRY, A. W..... Univ. Minn. Agr. Expt. Sta. Tech. Bull. 22 (1924).
- (23) HOPKINS, J. C..... Rept. Plant Path. for 1929. Rept. of Secy., Dept. Agric. S. Rhodesia for 1929, (1930) 84-86.
- (24) HYNES, H. J..... Sci. Bull. Dept. Agric. N.S.W. 47 (1935).

- (25) HYNES, H. J..... Journ. Roy. Soc. N.S.W. 70 (1937) 378-391.
- (26) HYNES, H. J..... Jour. Aust. Inst. Agric. Sci. iii, 4 (1937) 212-218.
- (27) HYNES, H. H..... Sci. Bull. Dept. Agric. N.S.W. 61 (1938).
- (28) ITO, S..... Proc. Imper. Acad. Tokyo 6 (1930) 352-355. (Seen Abstract in Rev. Appl. Myc. X: 232.)
- (29) ITO, S. & KURIBAYASHI, K..... Ann. Phytopath. Soc. Japan 11 (1927) 1-8. (Seen Abstract in Rev. Appl. Myc. VII: 54.)
- (30) ITO, S. & KURIBAYASHI, K..... Journ. Fac. Agric. Hokkaido Imper. Univ. Sapporo, Japan 29 (1931) 85-125. (Seen Abstract in Rev. Appl. Myc. X: 514.)
- (31) KURIBAYASHI, K..... Trans. Sapporo Nat. Hist. Soc. 10 (1929) 138-145, 162. (Seen Abstract in Rev. Appl. Myc. VIII: 438.)
- (32) MARCHIONATTO, J. B..... Bol. Min. Agric. Nac., Buenos Aires 29 (1930) 457-462.
- (33) MCKINNEY, H. H..... U.S. Dept. Agric. Bull. 1347 (1925).
- (34) MCRAE, W..... Scient. Repts. Imper. Inst. Agric. Res. Pusa (1931-2) 122-140.
- (35) MCRAE, W..... Scient. Repts. Imper. Inst. Agric. Res. Pusa (1932-3) 134-160.
- (36) MITRA, M..... Trans. Brit. Myc. Soc. 15 (1930) 254-293.
- (37) MITRA, M..... Trans. Brit. Myc. Soc. 16 (1931) 115-127.
- (38) MITRA, M. & BOSE, R. D..... Indian Journ. Agric. Sci. 5 (1935) 449-484.
- (39) MITRA, M. & MEHTA, P. R..... Indian Journ. Agric. Sci. 4 (1934) 943-975.
- (40) MOURASHKINSKY, K. E..... (Abstract seen in Rev. Appl. Myc. XIX: 391.)
- (41) NATTRASS, R. M..... Rept. Dept. Agric. Kenya for 1938 (1939) 42-47. (Seen Abstract in Rev. Appl. Myc. XIX: 71.)
- (42) NISIKADO, Y..... Japan. Jour. Bot. 4 (1928) 99-112. (Seen Abstract in Rev. Appl. Myc. VII: 519.)
- (43) NISIKADO, Y..... Ber. Ohara Inst. für Landw. Forsch. 4 (1929) 111-126.
- (44) NISIKADO, Y. & MIYAKE, C..... Ber. Ohara Inst. für Landw. Forsch. 3 (1926) 221-266.
- (45) O'GARA, P. J..... Phytopathology, 5 (1915) 323-326.
- (46) RAISTRICK, H..... Rept. London. Sch. Hyg. 1934-5, (1935) 27-30. (Seen Abstract in Rev. Appl. Myc. XV: 170.)
- (47) RAVN, F..... Bot. Tidsskrif Bd. 23 (1900) 101-322.
- (48) RAVN, F..... Zeits. Pflanzenkr. 11 (1904) 1.
- (49) SACCARDO, P. A..... Sylloge Fungorum, 25 volumes (1882-1931).
- (50) SMITH, N. J. G..... Ann. Appl. Biol. 16 (1929) 236-260; Ibid. 17 (1930).
- (51) SMITH, N. J. G. & PUTTERILL, K. M. S. Afr. Journ. Sci. 29 (1932) 286-295.
- (52) SMITH, N. J. G. & PUTTERILL, K. M. S. Afr. Journ. Sci. 30 (1933) 198-205.
- (53) SMITH, N. J. G. & RATTRAY, J. M. S. Afr. Journ. Sci. 27 (1930) 341-351.
- (54) STEVENS, F. L..... U.S.A. Dept. of Reg. & Educ. Div. Nat. Hist. Survey Bull. 14 (1922) 77-185.
- (55) SUBRAMANIAM, L. S..... Indian Journ. Agric. Sci. 6 (1936) 11-16.
- (56) SYDOW, H., MITTER, J. H. & TANDON, R. N. Ann. Myc. 35 (1937) 239.
- (57) THOMAS, K. M..... Rept. Govt. Mycologist, Madras, 1938-39 (1939). (Seen Abstract in Rev. Appl. Myc. XIX: 258.)
- (58) TULLIS, E. C..... Journ. Agric. Res. 47 (1933) 675.
- (59) VAN DER BYL, P. A..... Union of S. Afr. Dept. Agric. Sci. Bull. 10 (1918).
- (60) WAKEFIELD, E. M. & MOORE, W. C. Trans. Brit. Myc. Soc. 20 (1936) 97-109.

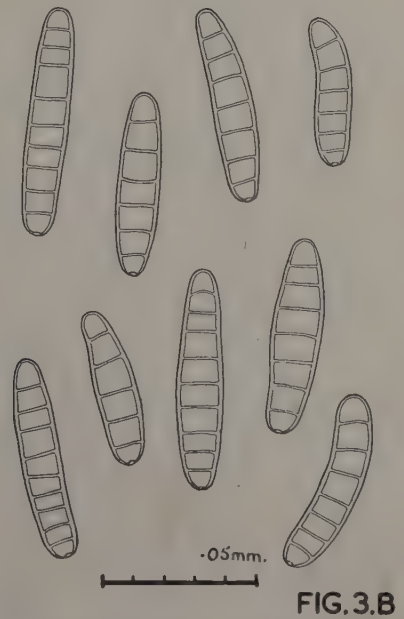
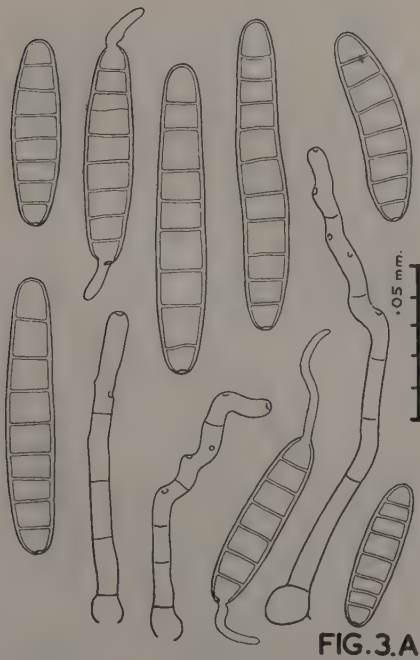
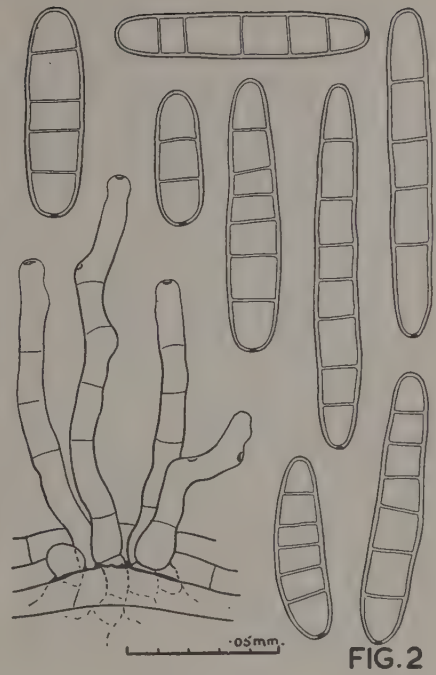
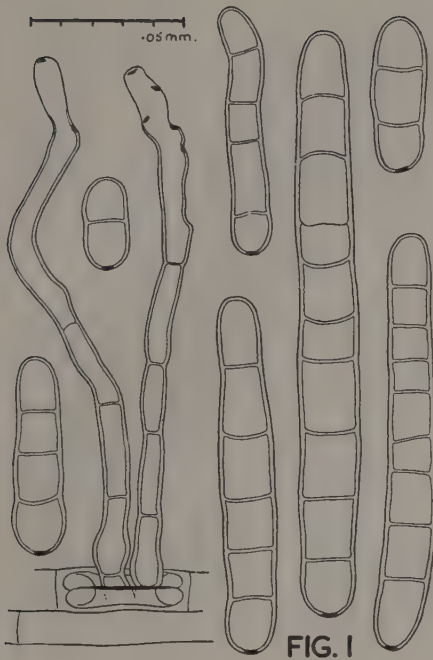


FIG. 1.—*H. teres*. FIG. 2.—*H. gramineum*. FIG. 3a, 3b.—*H. mediocre*.



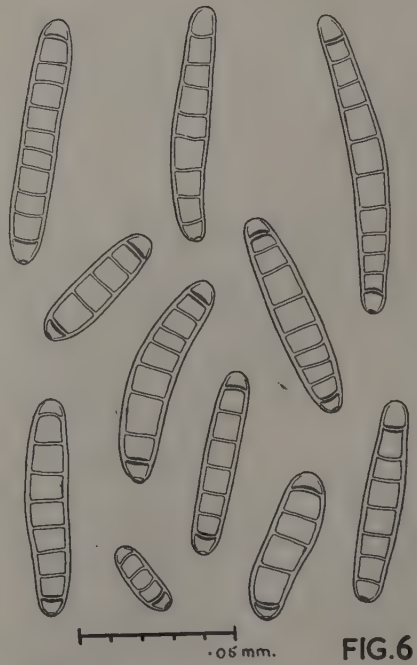
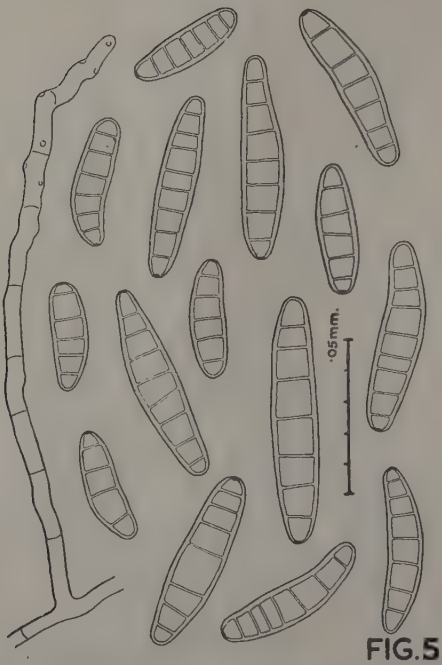
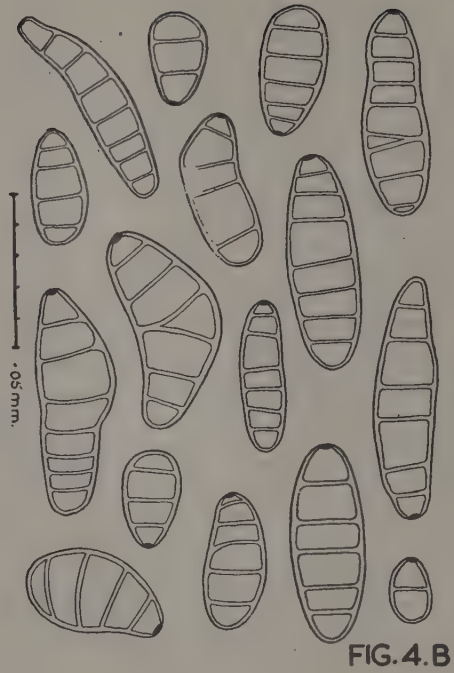
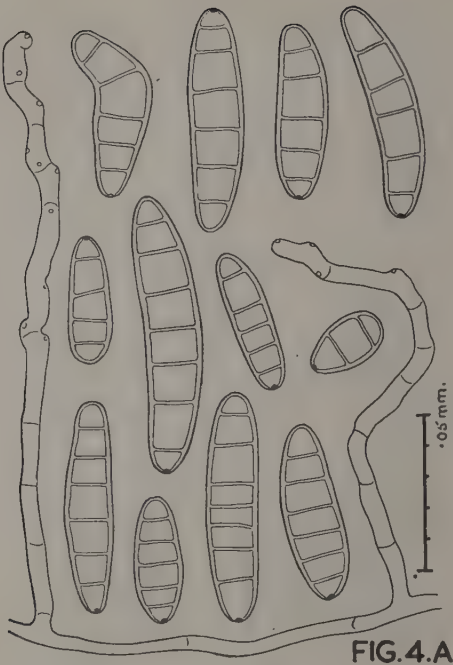


FIG. 4a, 4b.—*H. sativum*. FIG. 5.—*Helminthosporium* N. FIG. 6.—*H. bicolor*.

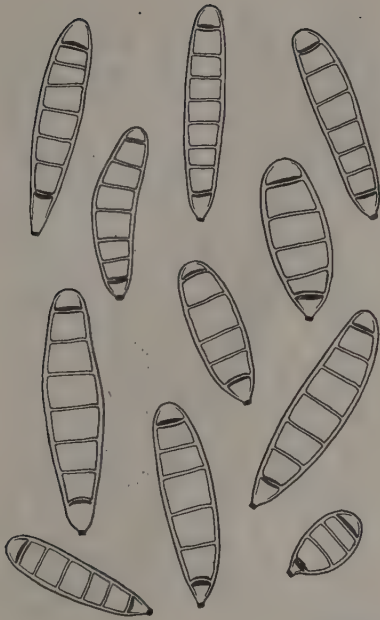


FIG. 7

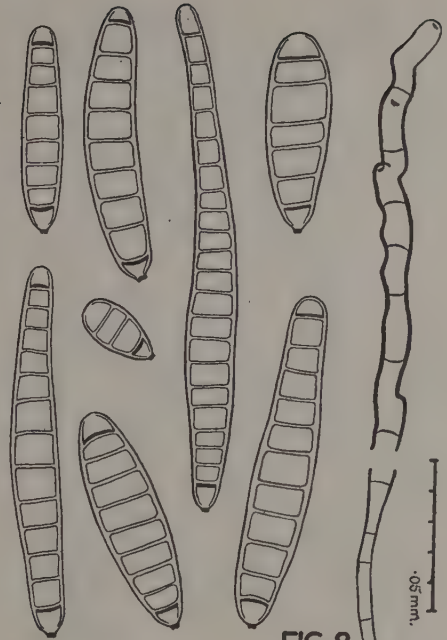


FIG. 8

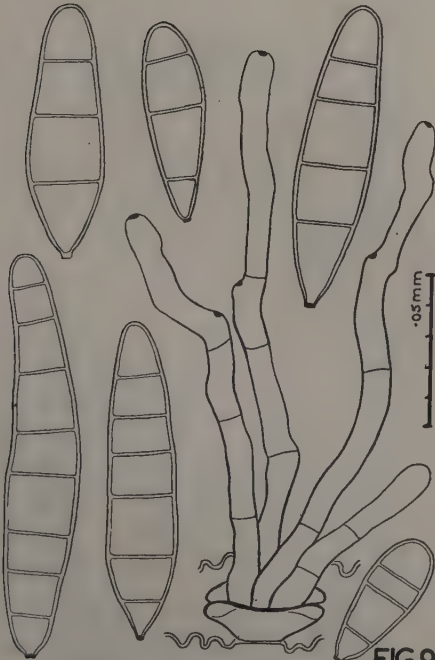


FIG. 9

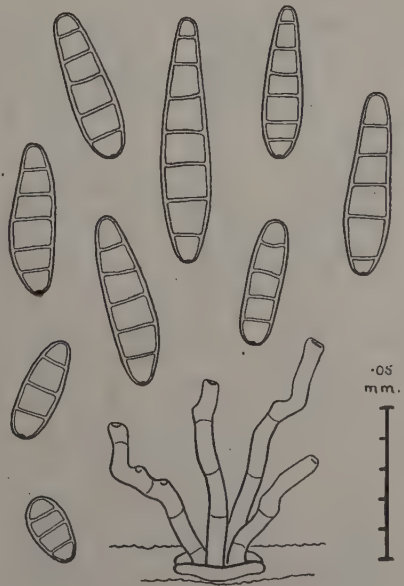


FIG. 10

FIG. 7.—*H. halodes*. FIG. 8.—*H. rostratum*. FIG. 9.—*H. turcicum*.  
FIG. 10.—*H. leucostylum*.

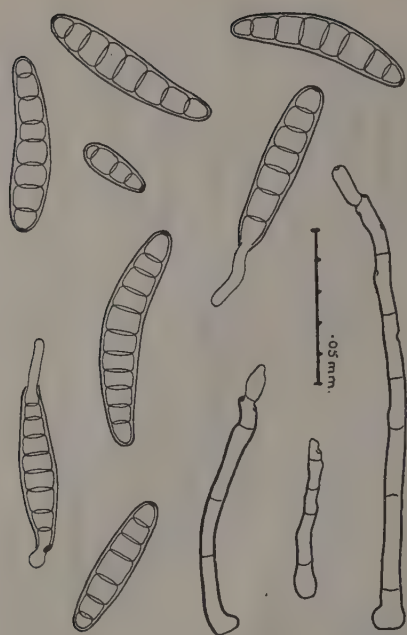


FIG. 11

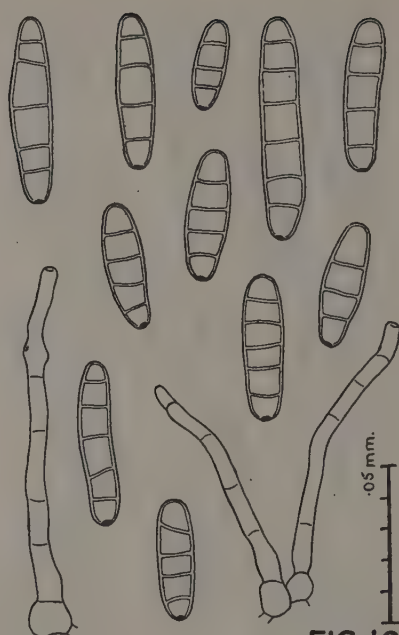


FIG. 12

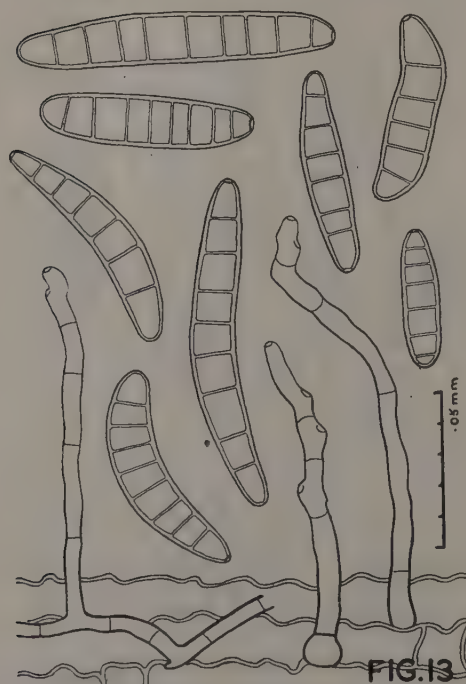


FIG. 13

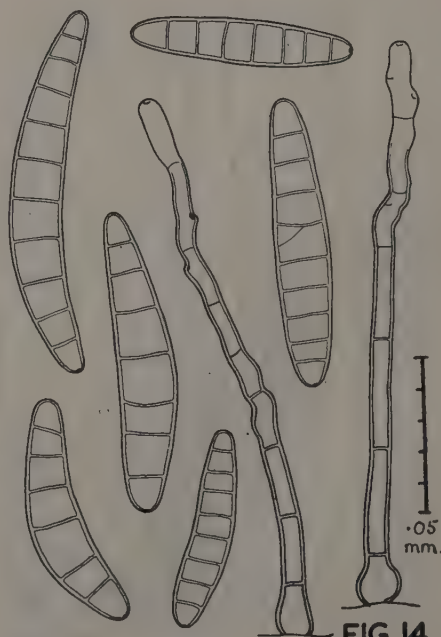


FIG. 14

FIG. 11.—*H. cynodontis*. FIG. 12.—*H. brizae*. FIG. 13.—*H. sacchari*.  
FIG. 14.—*H. leersii*.



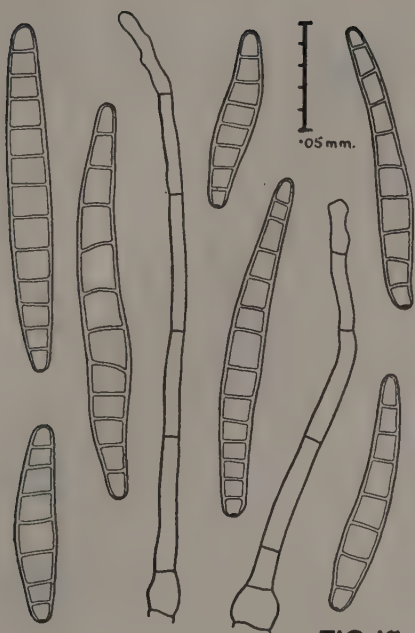


FIG. 15.A

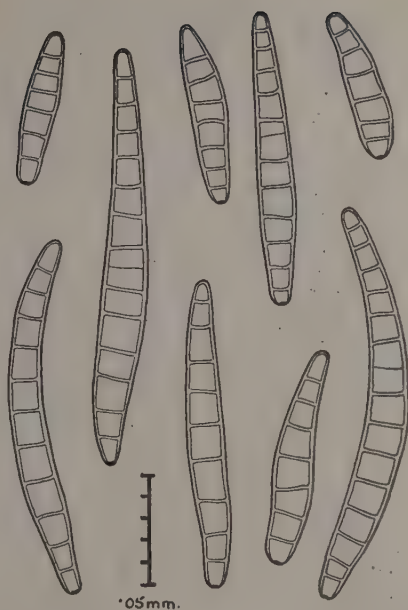


FIG. 15.B

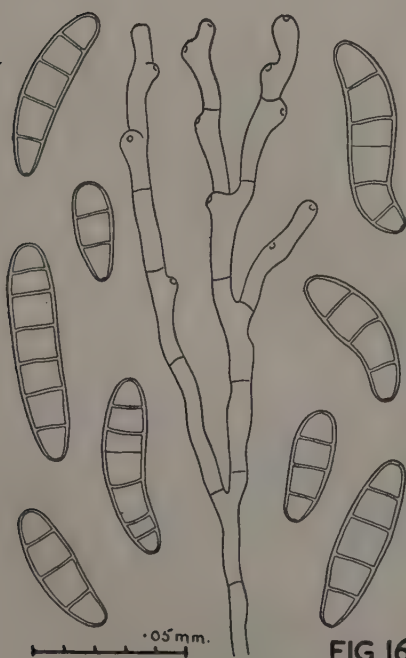


FIG. 16

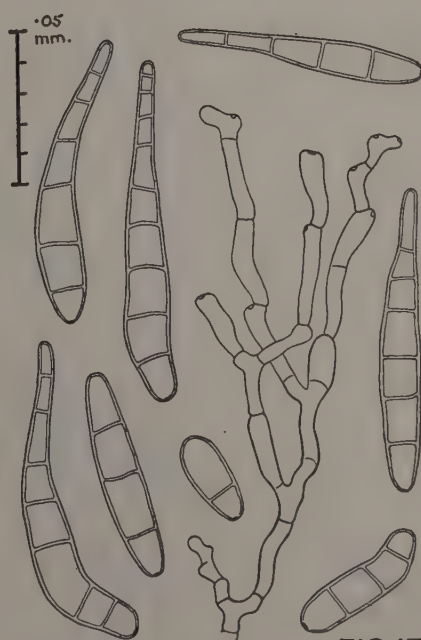


FIG. 17

FIG. 15a, 15b.—*H. urochloae*. FIG. 16.—*H. ravenelii*. FIG. 17.—*H. miyakei*.

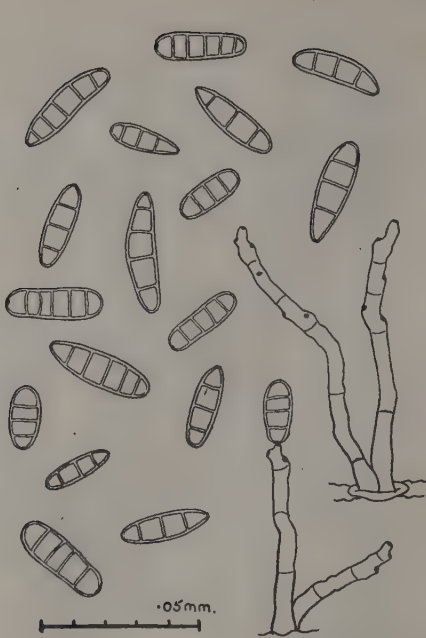


FIG. 18

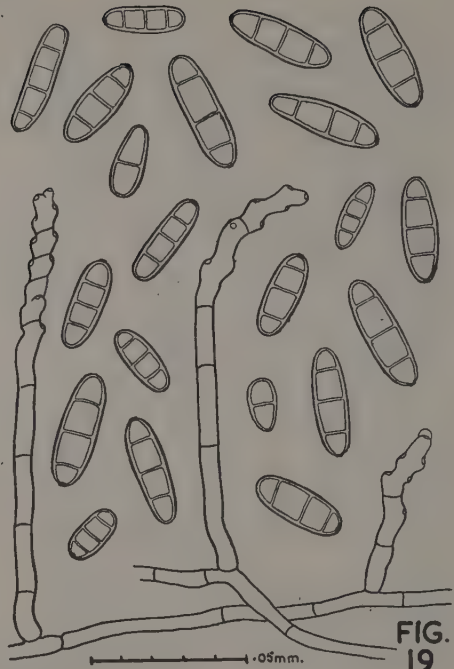


FIG. 19

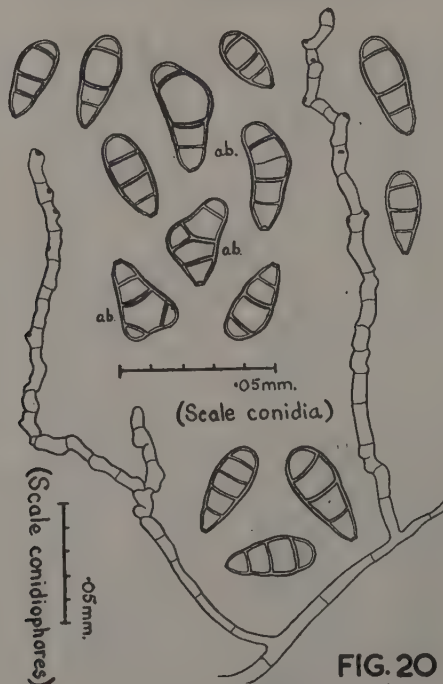


FIG. 20

FIG. 18.—*H. dematioides*. FIG. 19.—*Curvularia spicifera*.  
FIG. 20.—*Curvularia* species.

# Concerning some South African *Pestalotiopsis* Steyaert.

(*Pestalotia* Auct. non de Not.)

By

R. L. Steyaert.

(Institut National pour l'Etude Agronomique du Congo Belge.)

In an attempt to study type specimens of *Pestalotiopsis* Steyaert (*Pestalotia* Auct. non de Not.), I have been privileged to borrow type material of some South African species. Unfortunately some of this type material, of which only fragments were available to my study, was insufficient; it was either too poor in conidia or bore none or only broken ones.

However, I have been able to gather sufficient data to substantiate some fundamental modifications in the list of South African species.

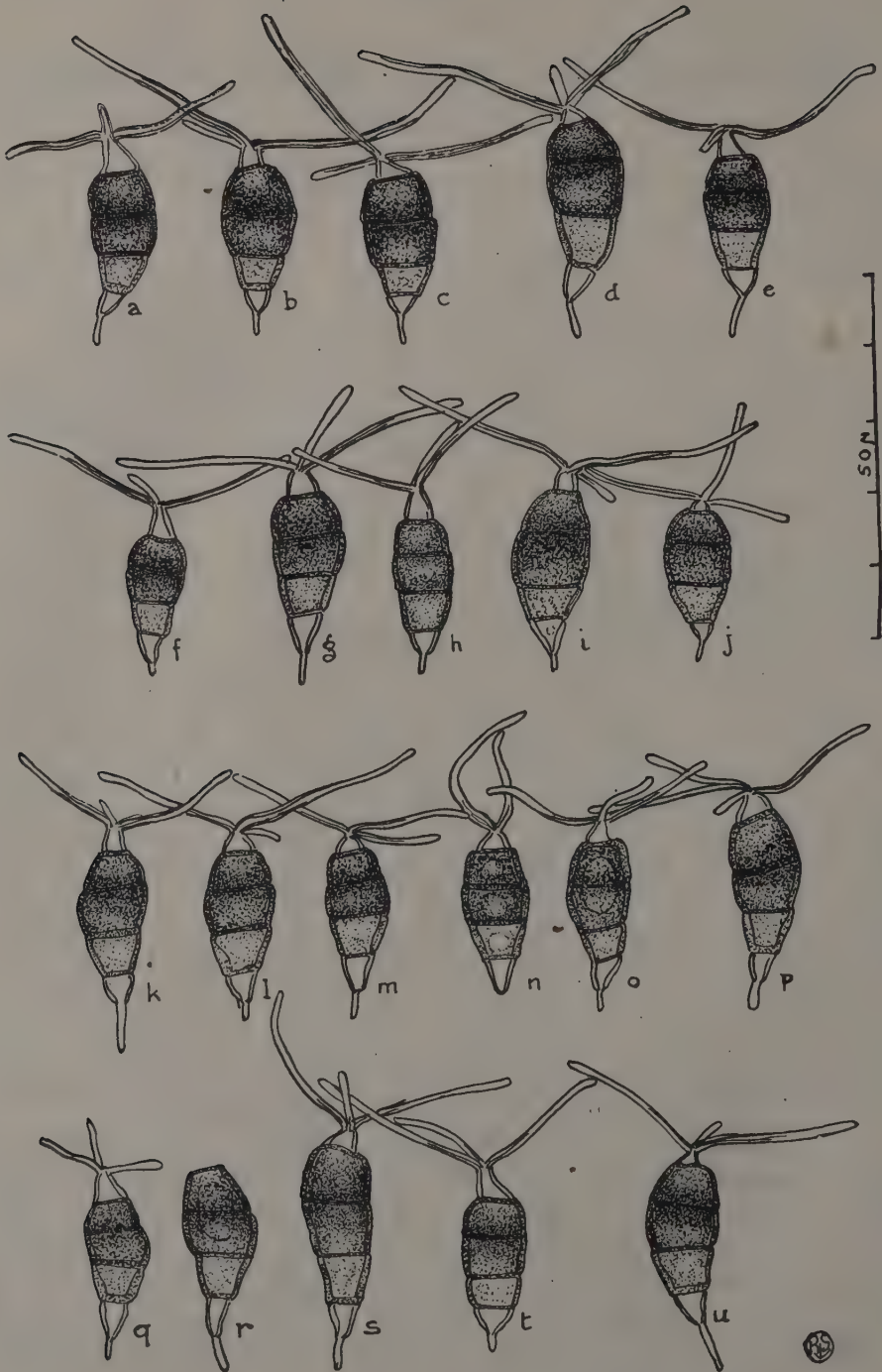
As the study of this batch of material progressed it soon became apparent to me that one and the same species had been considered different according to the host on which it occurred.

It is common knowledge that mycologists, specially those dealing with phytocolous species, have always been impressed by the "Host-species" relationship. With this host specificity in mind many species unrecorded on a host have been considered as new. Considering the enormous difficulties involved in the determination of species for such extensive genera as *Pestalotiopsis* it is a point of view that has been profitable for practical purposes, mainly because specimens have been described and published and are now on record and available. It is my opinion that authors should not be extensively criticised on that account. In the absence of a thorough and well-made revision it is a situation that is inevitable, but as the systematics of Mycology progresses it is to be remedied. The species concept with saprophytic or semi-saprophytic fungi such as *Pestalotiopsis* should be based on a much broader view. One is lead to this conclusion when a great number of specimens can be examined. Dimensions may be misleading and I do not uphold that I have never been misled myself. Morphological characters are of course the main discriminating factors and on this basis it is apparent that within the South African species many synonyms have been published. The ones that were offered to my study are a typical example of this contention.

The following species were published or redescribed in *Bothalia* 4: 821-831: 1948 by E. M. Laughton: *Pestalotia burchelliae* Laughton, *P. caffra* Sydow, *P. laughtonae* Doidge, *P. encephalartos* Laughton, *P. milletiae* Laughton, *P. pelargonii* Laughton, *P. podocarpi* Laughton non Dennis, *P. rapanae* Laughton non Viégas.

The conidia of all these species are claviform, with the two upper, coloured cells a deep, opaque, fuliginous brown and with an opaqueness more pronounced round the septum separating the cells. The setulas are relatively thick, usually with a clearly visible if not wide lumen. The dimensions of the conidia have a range that is given in Table 1, in which my measurements are compared with those of E. M. Laughton. Mine are the result of the standard technique I have used throughout my studies on this genus. About twenty conidia are drawn for each specimen with a camera lucida and with the same optical equipment. All drawings are thus immediately comparable and measurable with the same scale in all their details. In Figure 1 are given sample drawings of approximately the biggest and the smallest conidia of each specimen of the above-mentioned species.





If for some specimens there are some plus or minus variations the distinction cannot be, in my opinion, above the varietal level. Even so, I think the variations are due more to the host difference than to varietal distinctions.

If these measurements are compared with those I have given for *Pestalotiopsis glandicola* (Cast.) Steyaert in Bull. Jard. Bot. Etat, Brux. 19: 352-353: 1949, it will be seen that there is a very definite identity. Also, the same morphological characters as described above can be observed with this species.

The following synonymy is therefore justified:—

***Pestalotiopsis glandicola*** (Cast.) Steyaert in Bull. Jard. Bot. Etat Brux. 19: 330-334, 352-353: 1949.

*Pestalotia caffra* Sydow in Ann. Mycol. 12: 266: 1914, fide isotype in Nat. Herb. S. Afr. Pretoria, E. M. Doidge 6630, Isipingo, Natal, Nov. 1913.

*P. burchelliae* Laughton in Bothalia 4: 821: 1948, fide F. S. Laughton 34912 holotype in Herb. loc. cit.

*P. laughtonae* Doidge in loc. cit., p. 824, fide E. M. Laughton 35145 holotype, 35146, 34916 in Herb. loc. cit.

*P. encephalartos* Laughton in loc. cit., p. 823, fide Malvern 861, in Herb. loc. cit.

*P. milletiae* Laughton in loc. cit., p. 825, fide E. M. Laughton 33437 holotype in Herb. loc. cit.

*P. pelargonii* Laughton in loc. cit., p. 827, fide E. M. Laughton 34918 holotype in Herb. loc. cit.

*P. podocarpi* Laughton non Dennis in loc. cit., p. 827, fide E. M. Laughton 34917 holotype in Herb. loc. cit.

*P. rapanae* Laughton non Viégas in loc. cit., p. 829, fide E. M. Doidge 17171 holotype in Herb. loc. cit.

Unfortunately I have been able to retrieve only fragments of conidia, usually the coloured cells only, from the fragments of the types of *P. laurophylli* and *P. ocoteae*, but what I have observed on these suggests strongly that they also might be considered as synonyms.

On the specimen Doidge 17169, I have been able to observe the beautiful conidia of *Pestalotia trichocladi* Laughton for which I make the new combination:—

***Pestalotiopsis trichocladi*** (Laughton) Steyaert comb. nov.

*Pestalotia trichocladi* Laughton in Bothalia 4: 829: 1948, fide Doidge 17169 holotype in Nat. Herb. S. Afr., Pretoria.

This species has conidia of remarkable size (see Table 1) specially in regard to the setulas. Laughton did not record that they are spatulate. My observations show that they are definitely so, with a wide lumen nearly the whole length. The coloured cells are concolorous. This feature places the species very close to *P. planimi* (Vize)

---

FIG. 1.—Conidia of *Pestalotiopsis glandicola* (Cast.) Steyaert, from type specimens of: a-b, *Pestalotia burchelliae* Laughton (F. S. Laughton, 34912); c-d, *P. caffra* Sydow (Doidge, 6630); e-f, *P. encephalartos* Laughton (Malvern, 861); g-h, *P. laughtonae* Doidge (E. M. Laughton, 35145), i-j (Laughton, 34916), k-l, (E. M. Laughton, 35416); m-n, *P. milletiae* Laughton (E. M. Laughton, 33437); o-p, *P. pelargonii* Laughton (E. M. Laughton, 34918); q-r, *P. podocarpi* Laughton non Dennis (E. M. Laughton, 34917); s-u, *P. rapanae* Laughton non Viégas (Doidge, 17171).

Steyaert, which has much smaller setulas and bigger conidia. The drawings of three conidia of *P. trichocladi* are given in Fig. 2.

Several other specimens (*P. pterocelastri* Laughton in loc. cit., p. 828; *P. cassinis* Laughton in loc. cit., p. 822; *P. watsoniae* Verw. et Dipp. in S. Afr. Journ. Sci. 27: 327: 1930) gave such scanty or incomplete material that no opinion can be offered as to the validity of these species. Regarding the type specimen of *P. cassinis*, there were individual acervuli in which the conidia had coloured cells ranging from con-colourous, and with sizes as given by E. M. Laughton for *P. cassinis*, to the versicoloured type of conidium of *P. glandicola*. It may be that immature stages of *P. glandicola* have been mistaken for a new species.

With regard to *P. pterocelastri*, unfortunately no conidia were retrievable from the part of the specimen sent, but judging by Laughton's measurements this species is very close to, if not identical with, *P. ilicis* (West.) Steyaert.

The specimen of *P. watsoniae* gave abundant conidia but these were incomplete and lacked setular ornaments. There is no doubt that this species belongs to the genus *Truncatella* Steyaert, but in the absence of setulas I cannot decide on the validity of the species. Authors have so often described as plurisetulate, species which in reality possess a single but ramified setula, that I cannot decide without having personally seen the arrangement of the setae. As far as the coloured cells are concerned, *P. watsoniae* is no different from *Truncatella ramulosa* (V. Beyma) Steyaert or from

*T. conorum-piceae* (Tubeuf) Steyaert.

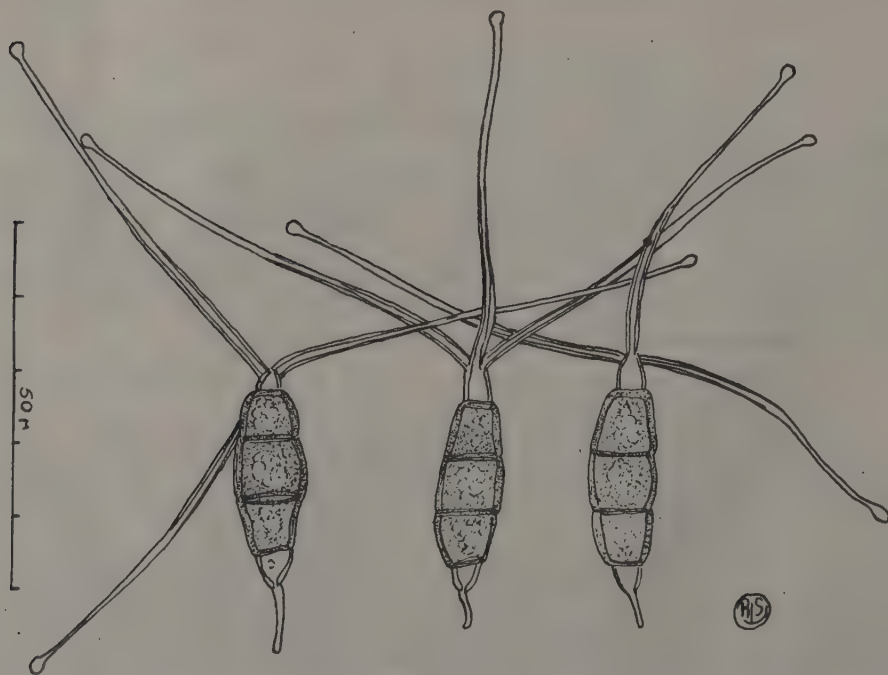


FIG. 2.—Conidia of *Pestalotiopsis trichocladi* (Laughton) Steyaert, X 1000. From type specimen of *Pestalotia trichocladi* Laughton (Doidge, 17169).



TABLE I.  
MEASUREMENTS IN MICRONS OF THE CONIDIA AND THEIR PARTS.

Species and Number of Specimen.	STEYAERT.						LAUGHTON.						
	Conidium.			Colored Cells, Length.	Setulas.		Pedicel.	Conidium.		Colored Cells Length.	Setulas.		Pedicel.
	Length.	Width.	Num- ber.		Length.	Length.		Width.	Number.		Length.		
<i>P. glandicola</i> (Cast.) Steyaert,.....	23-25-29	9-10-5-12	16-16-9-18	2-3	15-20-8-30	2-3-4-6	22-25	7-5-8	15-17-5	3-4	20-30	5-7	
<i>P. burchelliae</i> .....	22-24-5-27	9-10-6-12	16-17-7-20	2-3	20-27-9-34	(1)3-4-5-7	22-28	8-11	16-19	3	20-26	2-7	
<i>P. califfa</i> .....	20-21-8-23	8-9-4-11	14-14-7-16	2-3	14-20-1-26	2-4-7-18	22-23	6-9	12-5-17	2-3	17-23	4-6	
<i>P. encaphthalartos</i> .....	23-24-7-26	9-10-11	15-16-7-18	3	14-21-5-30	2-2-9-5	22-5-25	9-11	15-17-5	2-3	20-23	4-6	
<i>P. laughtoni</i> nr. 35145.....	21-24-7-27	9-10	16-17-18	2-3	15-21-8-28	3-4	—	—	—	—	—	—	
nr. 34196.....	20-24-1-27	(7)9-10-1-12	15-17-4-19	3	13-18-6-26	3-4	—	—	—	—	—	—	
<i>P. milletiae</i> .....	20-24-1-27	8-9-5-10	13-15-20	3	10-15-8-21	2-3-1-4	19-22	7-8	14-17-5	2-3	10-15	4-5	
<i>P. pelargonii</i> .....	21-21-6-25	9-9-5-12	15-16-9-19	2-3-4	12-18-4-26	2-4-6	20-25	7-5-9-5	14-17-5	2-3-4	15-25	5-7	
<i>P. podocarp</i> .....	22-23-2-25	9-10-2-12	14-16-18	—	—	—	20-23(25)	7-5-10	15 (16)	3-4	20-30	3-5-7	
<i>P. rapanae</i> .....	24-27-4-30	9-10-2-12	15-19-2-22	2-3	15-23-5-35	1-2-9-7	22-27-5	9-10	15-19	2-3	15-26-5	4-5	
<i>P. laurophylli</i> .....	—	8-9	15-16-18	—	—	—	20-25	7-5-9(10)	14-17-5	2-3	17-5-25	2-10	
<i>P. ocoteae</i> .....	—	7-8-5-10	16-18-21	—	—	—	22-5-27-5	6-7-5	15-18	2-3	15-25	5-7	
<i>P. trichocladi</i> .....	28-31-4-34	8-9-6-11	20-22-4-24	2-3	43-52-70	3-6-10-30	-37-5	7-5-9	20-25	2-3-4	45-60	6-12	
<i>P. pteroclastri</i> .....	—	—	—	—	—	—	(25)30-34 (37-5)	9-10	20-25	3	20-44	5-10	
<i>P. watsoniae</i> .....	—	7-8-9	12-13-5-15	—	—	—	17-22-5	7-5-9	12-5-16	4-5	15-30	30	



# The Morphology and Anatomy of *Utricularia* *Transrugosa* Stapf.

By

J. Slinger.

## INTRODUCTION.

Kamienski, in 1897, recognised five genera of the family LENTIBULARIACEAE. These are, *Pinguicula*, *Genlisea*, *Polypompholyx*, *Utricularia* and *Biovularia*. It is now known that all these plants are carnivorous and that prey is captured and digested by means of specialised vegetative organs which constitute the "traps". Among the LENTIBULARIACEAE occur examples of the simplest traps (*Pinguicula*), the most complex of the pitfall type (*Genlisea*), and the trap or bladder of *Utricularia* which has attained a degree of structural complexity and perfection of mechanism for which there is no analogue among other plants.

The *Utricularias* show a wide range of variation in form and habit. The plants may be freely-floating or anchored aquatics, or epiphytic, or they may be terrestrial in wet to moist sandy soils. Among the aquatic forms are found the larger (e.g. *U. stellaris*) and the smaller species of *Utricularia* (e.g. *U. cymbantha*), while the terrestrial species, with few exceptions are small. The epiphytic forms are often remarkable for the size and showiness of their flowers.

The genus is of world-wide distribution, the most widely distributed species being the submerged or semi-submerged aquatics. They are found throughout North America including Greenland, in Europe and in Asia. Related species extend throughout the tropics into South America, South Africa, Australia and New Zealand. Terrestrial species are widely distributed in the tropics of the Old and New worlds.

Fig. 1 shows the distribution of *Utricularia* in Africa. It will be seen that aquatic and terrestrial species are well represented, while only one epiphytic species has been recorded (*U. bryophila*). Most common are the terrestrial species, of which *U. transrugosa* Stapf is an example. It will also be seen from Fig. 1 that six species, all terrestrial, are limited to Africa south of the central lake area. These species are *U. transrugosa*, *U. kirkii*, *U. capensis*, *U. livida*, *U. ecklonii* and *U. sandersonii*. Twenty-three species are restricted to west, central and northern regions, while the nine remaining species are distributed throughout Africa. Several of the African species are also found in tropical America (*U. obtusa*, *U. foliosa*, *U. subulata*), while others occur in Algiers and Portugal (*U. exoleta*) and through India to China, Malaya, and tropical Australia (*U. stellaris*, *U. striatula*).

As previously stated, *U. transrugosa* is one of the small terrestrial species of *Utricularia* and is found growing in vleis or boggy ground along stream banks. It will be seen from Fig. 1 A that the species has been recorded from the Transvaal and also from Southern Rhodesia near Salisbury, but is not recorded from any locality north of the Zambesi.





*U. transrugosa* was first described by O. Stapf in *Flora Capensis IV* 2, 428 (1904). His description was based on specimens from Barberton, Johannesburg and Rustenburg. Rand 727, which was collected in boggy ground near Johannesburg, was one of these and had previously been misidentified by Moore in *Journal of Botany* (1903), 405, as *U. sanguinea* Welw. It is the first published record of *U. transrugosa* from the Witwatersrand. Later, in 1951 and 1952, the plant was found at Bryanston, near Johannesburg, in a semi-dry vlei associated with sedges, *Drosera cf. burkeana* and *Lobelia cf. decipiens*. It was also found in very wet mud along the bank of a nearby stream.

---

*Legend.*

- |   |   |
|---|---|
| A. <i>U. transrugosa</i> Stapf. (Ter.).   | T. <i>U. striatula</i> Smith. (Ter.).   |
| B. <i>U. odontosperma</i> Stapf. (Ter.).  | U. <i>U. rigida</i> Benj. (Aq.).        |
| C. <i>U. sanguinea</i> Oliv. (Ter.).      | V. <i>U. thoningii</i> Schumach. (Aq.). |
| D. <i>U. tribracteata</i> Hochst. (Ter.). | W. <i>U. trichoschiza</i> Stapf. (Aq.). |
| E. <i>U. kirkii</i> Stapf. (Ter.).        | X. <i>U. stellaris</i> Linn. (Aq.).     |
| F. <i>U. exilis</i> Oliv. (Ter.).         | Y. <i>U. villosula</i> Stapf. (Aq.).    |
| G. <i>U. linarioides</i> Welw. (Ter.).    | Z. <i>U. foliosa</i> Linn. (Aq.).       |
| H. <i>U. welwitschii</i> Oliv. (Ter.).    | a <i>U. platyptera</i> Stapf. (Aq.).    |
| I. <i>U. firmula</i> Welw. (Ter.).        | b <i>U. reflexa</i> Oliv. (Aq.).        |
| J. <i>U. baumii</i> Kam. (Ter.).          | c <i>U. charoides</i> Stapf. (Aq.).     |
| K. <i>U. prehensilis</i> E. Mey. (Ter.).  | d <i>U. diploglossa</i> Welw. (Aq.).    |
| L. <i>U. andongensis</i> Welw. (Ter.).    | e <i>U. cymbantha</i> Oliv. (Aq.).      |
| M. <i>U. spiralis</i> Smith. (Ter.).      | f. <i>U. obtusa</i> Swartz. (Aq.).      |
| N. <i>U. schweinfurthii</i> Bak. (Ter.).  | g. <i>U. exoleta</i> R. Br. (Aq.).      |
| O. <i>U. tortilis</i> Welw. (Ter.).       | h. <i>U. livida</i> E. Mey. (Ter.).     |
| P. <i>U. micropetala</i> Smith. (Ter.).   | i. <i>U. capensis</i> Spreng. (Ter.).   |
| Q. <i>U. manii</i> Oliv. (Ter.).          | j. <i>U. ecklonii</i> Spreng. (Ter.).   |
| R. <i>U. bryophila</i> Ridley. (Epi.).    | k. <i>U. sandersonii</i> Oliv. (Ter.).  |
| S. <i>U. subulata</i> Linn. (Sub-ter.).   | l. <i>U. papillosa</i> Stapf. (Ter.).   |

Aq. Aquatic including submerged, anchored or surface-floating forms.

Ter. Terrestrial.

Sub-ter. Sub-terrestrial.

Epi. Epiphytic.

In Hooker's *Icones Plantarum*, Tab. 2796 (1903) this plant was described as *U. livida* var. *transrugosa* Stapf. The two species *U. transrugosa* and *U. livida*, (Fig. 1, h) are distinguished by the markings on the palate of the lower corolla lip; in the former the palate is distinctly rugose, while in the latter it is narrower and tubercled.

Bladders, stolons, leaves, capsules and seeds were not available to Stapf for his description of *U. transrugosa*, and F. E. Lloyd (1942) in "The Carnivorous Plants" does not even refer to *U. transrugosa*. The object of this report is to give an adequate description of the anatomy and morphology of *U. transrugosa*, together with facts concerning the biology of this species which have become known during these investigations.

## MORPHOLOGY.

### (a) VEGETATIVE CHARACTERS.

This is a small perennial plant reaching a height of 6-10 cms. when in flower. Unless in flower, the plant is likely to be overlooked, as apart from the inflorescence, only the tips of the leaves appear above ground.

The vegetative morphology of *Utricularia* cannot be likened to that of any other flowering plant. In order to avoid confusion, the terms leaf, stolon and rhizoid will be used in this report, though it must be remembered that in *Utricularia* the distinctions between these three are ill-defined. The vegetative portions of the plant are almost entirely below soil-level, with just the tips of the recurved leaves appearing above ground. These leaves are simple, entire and spatulate in shape tapering towards the base into a cylindrical portion which is continuous with a stolon. In its expanded portion, the leaf is dark green above, paler below, often becoming reddish-brown with age. Because of the soft, succulent texture of the leaves, the dichotomously-branched midrib is often indistinct and cannot be seen at all with the naked eye in the lower cylindrical portion.

The stolons are very delicate, cylindrical, filiform strands of tissue which have a characteristic white, glistening translucence. They are much branched, and as will be seen later, this branching follows a pattern.

*U. transrugosa* is rootless. The rhizoids described by Stapf are problematical. When present, they occur in tufts at the base of an inflorescence, but cannot really be distinguished morphologically from the stolons. Indeed, the vegetative structures of *U. transrugosa* are so plastic, that a rhizoid can continue growth, branch and bear leaves and thus become a stolon. The leaves too, as will be seen from Fig. 2 are no more than unbranched, expanded stolons.

Minute stalked bladders (traps) are borne in great numbers on leaves, stolons and rhizoids. There appears to be no definite arrangement of bladders; they may be opposite or alternate and are not more frequent in one region than in another. As it is difficult and impracticable to separate the anatomy from the morphology of these bladders, this will be discussed collectively in a later section.

Numerous small glands are present over the outer surface of the vegetative parts of the plant and the epidermis is thickly cuticularised. (See anatomical section for structure of glands.)

*U. transrugosa* was frequently found associated with filamentous green algae (*Zygnema*, *Oedogonium*) which had become densely twisted and matted around stolons and leaves. These, at first glance, give the plant a hairy appearance, and can lead to confusion.



## (b) BRANCHING, AND ORIGIN OF THE INFLORESCENCE.

In spite of the plasticity of stolons, leaves and rhizoids these organs are arranged in positions bearing a clear relationship to one another.

The main stolon (St. 1, Figs. 2 and 3) is of indefinite growth. At various points along its length it gives rise to aerial shoots which will bear flowers. These aerial shoots or aerial stems are not to be confused with the "air-shoots" of Goebel (Lloyd, p. 223). Secondary stolons (St. 2) arise at the base of an aerial shoot at right angles to the main stolon and a short distance above the junction of the aerial shoot with the main stolon. A single primary leaf (Lloyd, Plate 23, Fig. 7) is always associated with an aerial shoot and originates in an angle between St. 1 and St. 2. These leaves are circinate away from the aerial shoot.

Rhizoids are formed in consecutive pairs alternately on opposite sides of the aerial stem, the first pair being at right angles to the secondary stolons. As the rhizoids may later become stolons, in Fig. 3, at a later stage of development, R1 may be St. 3, R2 would then be R1, and so on.

Secondary stolons and secondary leaves may also arise alternately along the main stolon between aerial shoots, while tertiary stolons and leaves may arise alternately along a secondary stolon. It will be seen that in this way a much branched plant bearing inflorescences may be formed, and that the branching conforms to a pattern with unexpected regularity.

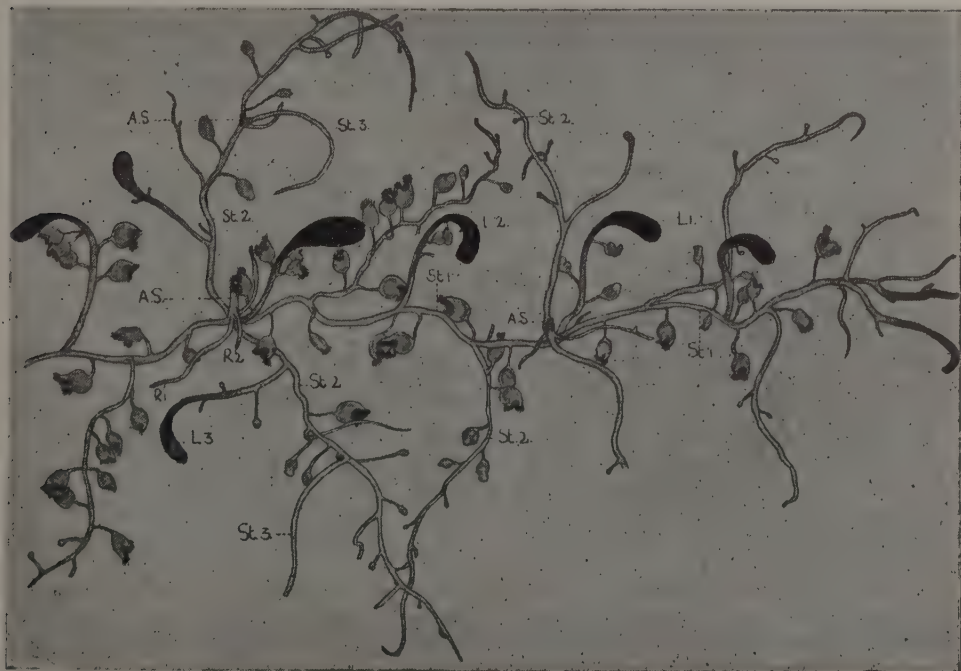


FIG. 2.—*Vegetative structures of U. transrugosa Stapf.*

The plant was freed of organic debris and soil particles with the aid of a fine jet of water.

A.S.: aerial shoot. St. 1: main stolon. St. 2: secondary stolon. St. 3: tertiary stolon. L1: primary leaf. L2: secondary leaf. R1, R2: rhizoids.

## (c) FLORAL CHARACTERS.

The erect aerial stem of *U. transrugosa* bears from 1–3 personate flowers which have a delicate honey-like scent. Pedicels are about 2 mm. long and are subtended by a bract which is often recurved in the fruit. 1–2 barren bracts are found near the base of the aerial stem. Two bracteoles arise at the base of the pedicel above the fertile bract. They are narrower than this bract but of equal length. The calyx consists of two reddish-purple sepals, 3 mm. long, which are persistent and become papery in the mature fruit.

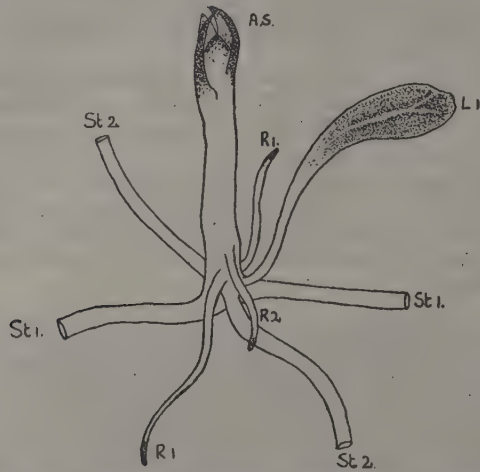


FIG. 3.—Young inflorescence showing origin, and branching of stolons.

This is an enlargement of a portion of the plant represented in Fig. 2. Lettering as for Fig. 2.

The corolla varies greatly in colour from mauve or purple with yellow markings on the palate, to pale yellow or white. Its upper lip is 6 mm. long and constricted in the centre, the lower half being broader than the upper half. The apical margin of this lip shows slight variation in that it is in some cases smoothly rounded and in others, emarginate. The lower lip rises from a reflexed spur, 7 mm. long, to arch forward and meet the upper lip; thence it is reflexed backwards and expands to form a platform 11 mm. broad, the margins of which are upturned. In the mouth formed with the upper lip it bears two lateral rugose swellings; each swelling usually has 20–30 transverse rugosities which are dark purple and velvety in appearance. These rugosities often converge or bifurcate forming in places a zig-zag pattern. The depression formed between the two lateral rugose swellings is variously marked with yellow patches.

Two stamens are attached to the lower lip at the mouth of the spur. When mature, they face away from the ovary and towards the mouth of the spur. Fig. 4 shows the stamen-ovary relationship in three stages of development of the flower. In (a), a very young bud, filaments are short and anthers very large and closely adpressed to the ovary. In (b) the filaments have elongated and anthers have separated and rotated so that they face each other, while in (c) the mature anthers have completed a rotation through 180° so that their previously outer margins become the inner margins, and the anthers face away from the ovary instead of towards it as in the bud. During this rotation the filaments become twisted. When fully mature the anthers adhere at the centre of their inner margins. Dehiscence is by means of longitudinal slits.

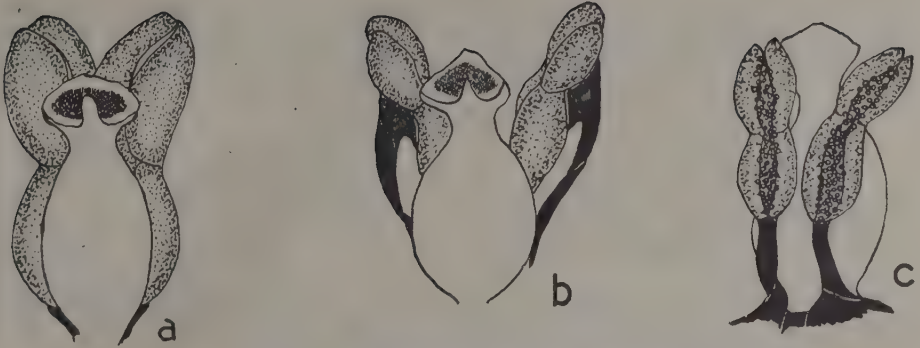


FIG. 4.—*Stamen-Ovary Relationship.*

a, b and c are drawn from flowers in progressive stages of development. Note broad point of attachment of anther to filament.

The ovary is globose and constricted at the apex into a short style which broadens out into a 2-lobed stigma, the upper lobe of which is narrow and acute and is adjacent to the upper corolla lip. The lower lobe is wide and fan-shaped and bears the stigmatic surface.

The fruit is a capsule with numerous seeds tightly packed on a free central placenta. Seeds are angular, predominantly wedge-shaped (Fig. 5) and the placenta has become convoluted and folded between them, so that when all the seeds are removed the placenta has the appearance of a fine honeycomb. The calyx and the ovary wall become papery in the fruit and dehiscence is by means of irregular longitudinal tears.

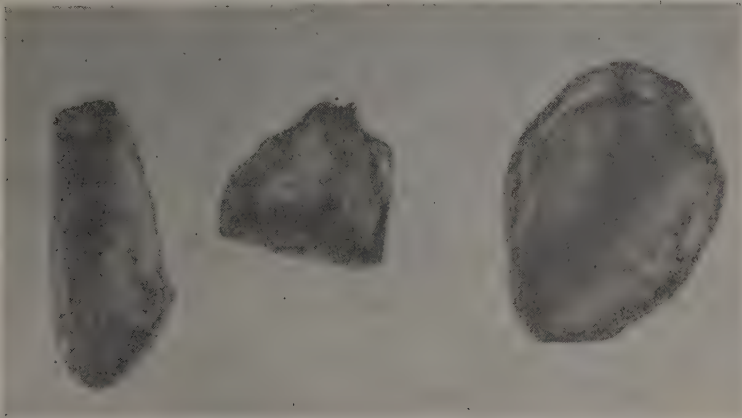


FIG. 5.—*Seeds of U. transrugosa Stapf in various positions.*

The broad, flattened surface of the seed faces externally (430  $\times$  nat.).

#### ANATOMY.

The microscopic and macroscopic structures of this plant proved to be different from other angiosperms. The anatomy of aerial shoot, leaf, stolon and bladder was studied. Observations were made primarily from microtomed sections, 15  $\mu$  and 20  $\mu$  thick. Material which had been preserved in 4 per cent formalin was embedded in 55 paraffin wax and the sections were later stained with safranin and fast green. As



the tissues of *Utricularia* are so delicate, hand sections and dissections were necessary to substantiate evidence from prepared slides. Especially in the case of bladders, microtomed sections should not be relied upon, as tearing and displacement of tissues might have lead to a wrong interpretation of bladder structure.

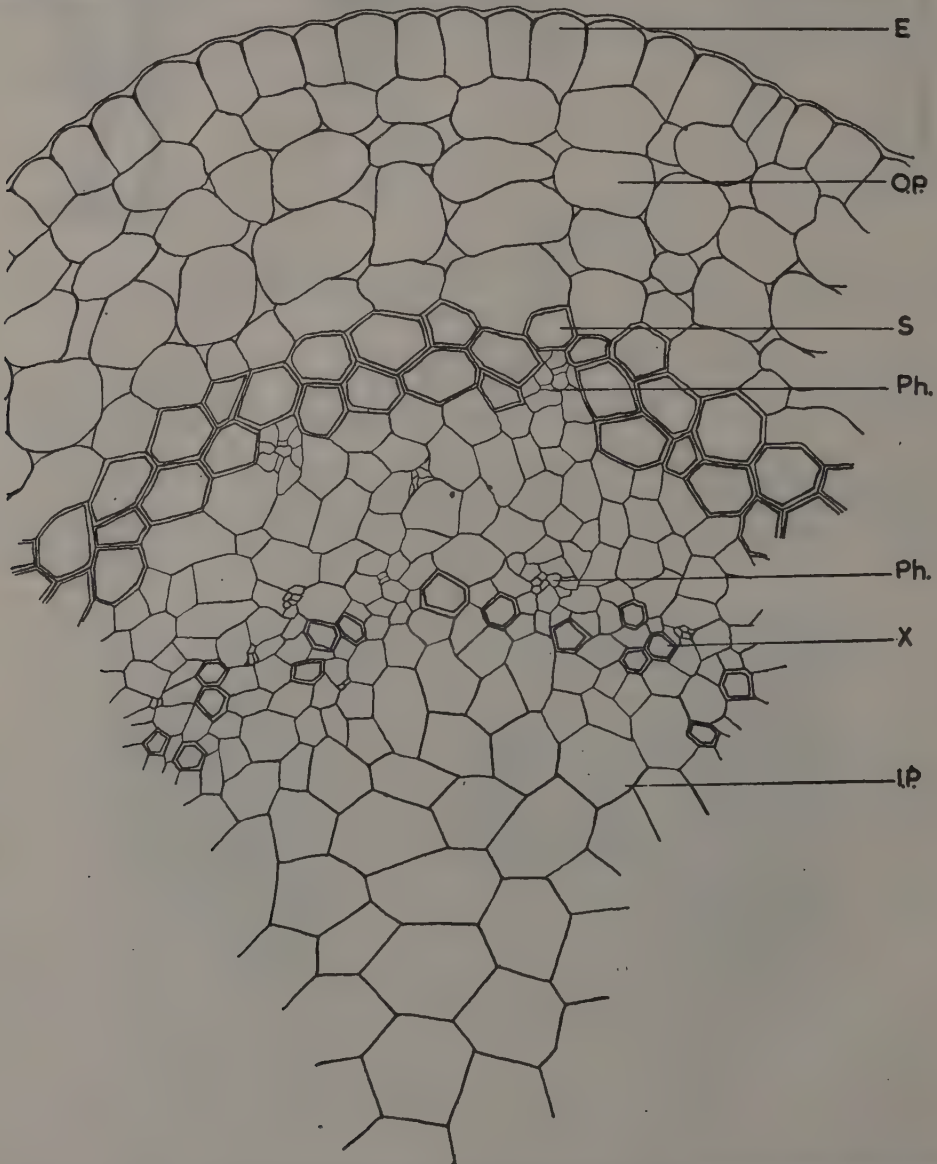


FIG. 6.—Portion of transverse section through aerial stem of *Utricularia transrugosa* Stapf.  
 E: epidermis. O.P: outer parenchyma (chloroplasts are not shown).  
 S: sclerenchyma band. Ph.: phloem. X: xylem vessel.  
 I.P: inner parenchyma.

## (a) ANATOMY OF THE AERIAL SHOOT.

Epidermal cells of the aerial shoot are large and heavily cuticularised. Their radial walls appear to be thickened towards the outside. Many stomata are present, particularly towards the base of an aerial shoot. (See leaf anatomy for structure of stomata.)

Immediately within the epidermis is a zone of parenchymatous tissue about 4 cells wide. These cells are rounded and arranged in longitudinal rows with numerous intercellular air-spaces. Chloroplasts are abundant in this region. No distinct endodermis could be seen. The outer parenchyma zone was bounded internally by a complete sclerenchyma band, 1-3 cells wide.

The vascular tissues of *U. transrugosa* are embedded in a groundwork of angular parenchyma cells, which are smaller towards the sclerenchyma zone becoming larger towards the centre of the stem. No air-spaces are present between these cells.

Xylem vessels are arranged in a circular zone a short distance from the sclerenchyma band. Vessels are scattered, occurring singly or in pairs. Thickening of their walls is either spiral or annular and both types of thickening may occur together in a single

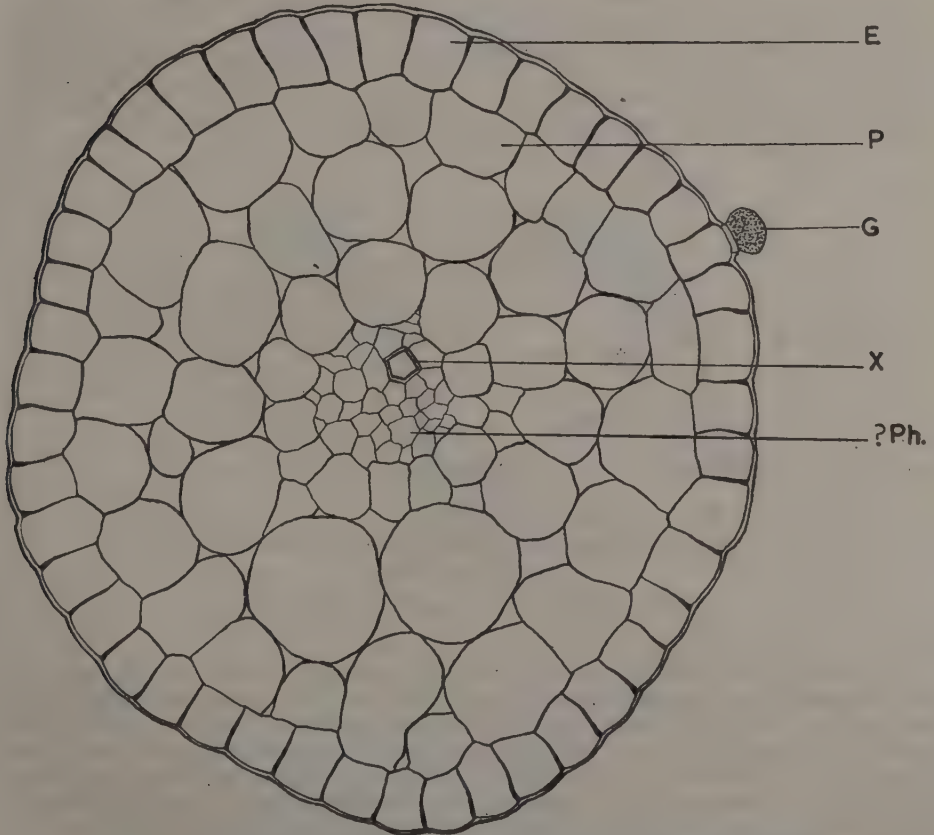


FIG. 7.—Transverssection the rough stolon of *U. transrugosa* Stapf.  
E: epidermis. P: parenchyma. G: gland. X: xylem vessel. ?Ph.: phloem.

vessel element. Small, thin-walled patches of tissue are found scattered in the angular parenchymatous region near the vessels, and similar patches occur abutting on the sclerenchyma zone. These patches were interpreted as phloem.

### (b) ANATOMY OF THE STOLON.

The epidermis and parenchyma of the stolons are similar to those found in the aerial shoot. In Fig. 7, one of the glands, which occur abundantly on the outer surface of the stolon, is shown. The inner basal cell is embedded in the epidermis; the middle cell is narrow and collar-like and bears the single rounded capital cell, which is not cuticularised.

Towards the centre of a stolon, parenchyma cells become smaller and closely packed. Here they surround a strand of thin-walled, tightly packed, angular cells in which a single xylem vessel is embedded. The xylem vessel is similar to those found in the aerial shoot. It is suggested that the angular cells may be phloem tissue.

### (c) ANATOMY OF THE LEAF.

The leaf, as stated previously, is no more than an expanded stolon.

Fig. 8 shows that the central strand of a stolon continues into a leaf and there it divides dichotomously once, or more rarely, twice. The single xylem vessel, present in the stolon, passes into a leaf but terminates before the vascular strand branches into two, the veins consisting thereafter of angular cells only. Chloroplasts are numerous in the parenchyma cells of the leaf. Mesophyll is undifferentiated.

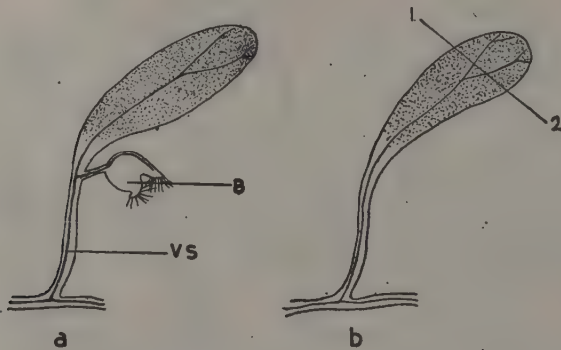


FIG. 8.—Schematic representation of leaves of *U. transrugosa* Stapf.

B: bladder. VS: vascular strand.

Epidermis and glands are similar to those described for stolons. Stomata are found towards the apex of the upper surface on the leaf, and very occasionally on the lower surface. They are not present in the lower cylindrical portion. This limited occurrence of stomata is to be expected as most parts of the leaf are usually embedded in mud or soil. The stomata are slightly sunken (Fig. 9) and, as will be seen from Fig. 10, they conform to the anomocyclic or "Ranunculaceous" type of Metcalfe and Chalk (1950) in that they are surrounded by cells which are indistinguishable in size, shape or form from those of the remainder of the epidermis.

The leaf epidermis does not strip readily, thus in order to study stomata, leaves were soaked overnight in Eau de Javelle and then the internal parenchymatous tissue



was scraped away, leaving the epidermis intact. For material which has been preserved in formalin, previous soaking in Eau de Javelle can be omitted.

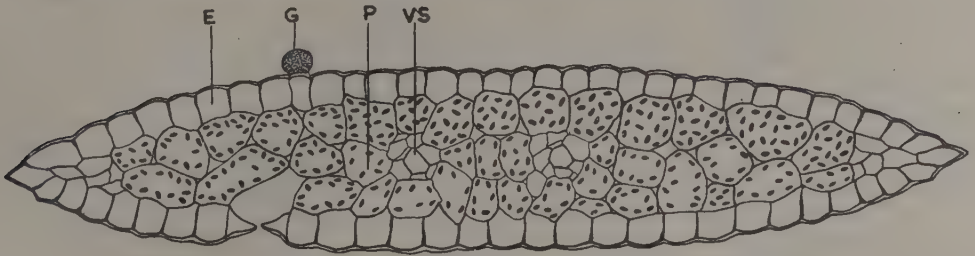


FIG. 9.—Transverse section through upper portion of leaf.

This section is cut through the line 1-2 of Fig. 8 b.

E: epidermis. G: gland. P: parenchyma with chloroplasts. VS: vascular strand.

Note absence of xylem vessels in this region.

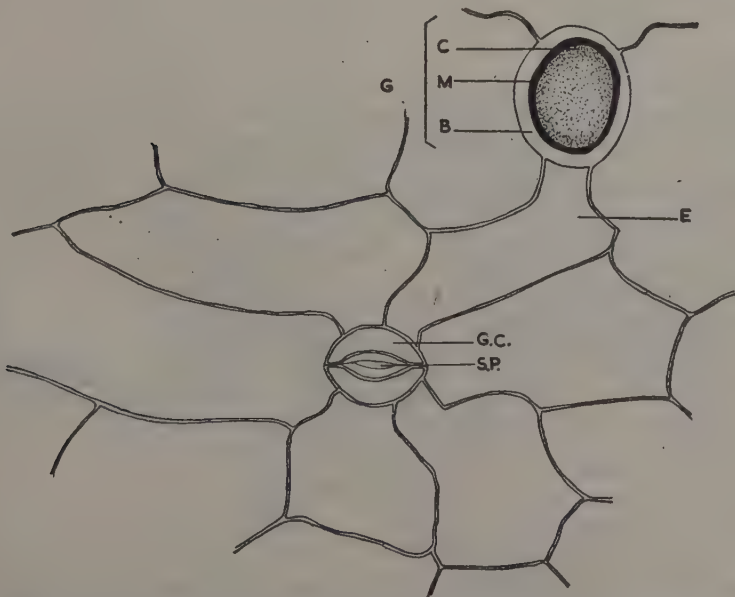


FIG. 10.—Epidermis, showing stoma and gland in surface view.

G: gland, which consists of C: capital cell, M: middle cell and B: basal cell.

G.C.: guard cell. S: stoma pore. E: epidermal cell.

The middle cell of the gland is represented by a dark line due to refraction caused by the spherical capital cell.

## THE MORPHOLOGY AND ANATOMY OF THE BLADDER.

It has already been noted that the bladders or traps are present in large numbers on stolons and leaves of *U. transrugosa*. They are small ovoid-shaped structures, 2 mm. long and 1 mm. broad, and are slightly flattened on the sides. They are attached to a stolon or leaf by a narrow stalk which varies considerably in length. The cells at this point of attachment are slightly thickened and possibly prevent the bladder from being torn away. The stalk is attached near the base of one end of the bladder, while at the opposite end the walls of the bladder are produced into an upper and a lower lip. The two lips are joined laterally by folds of tissue which form the cheeks. These structures together form a protective funnel-like entrance to the mouth of the bladder. Lloyd has stated that the stalk end of the bladder is ventral, the mouth end dorsal (p. 233). It is more convenient however to describe dorsal and ventral surfaces of the bladder to correspond with upper and lower lips. From Fig. 11 it will be seen that the lips carry numerous glandular hairs which interlock with one another across the mouth entrance. Each hair consists of 4 cells. The lowermost or "wall cell" is a prolongation of an epidermal cell. This is followed by a basal cell, a narrow cylindrical middle cell, and a capital glandular cell (see Fig. 12 b). The glandular hairs are arranged in six longitudinal rows on both upper and lower lips. On the cheeks, glandular hairs are shorter and uniseriate. The large number, and

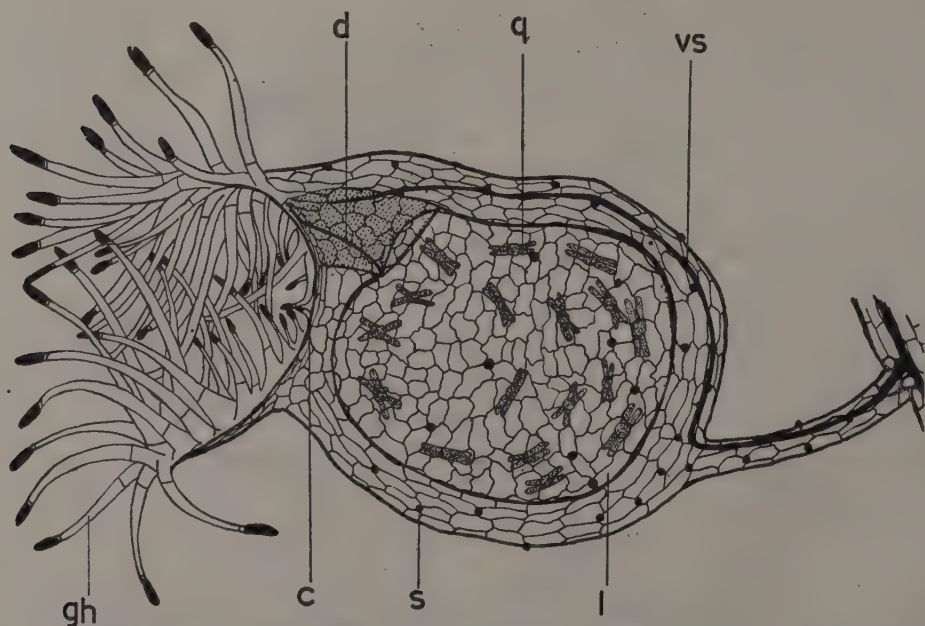


FIG. 11.—Cellular representation of bladder of *U. transrugosa* Stapf.

Only the outer wall is shown with the quadrifids being visible because of transparency of the bladder wall. The stippled area in the upper left of the bladder is the mouth region.

d: door. q: quadrifid. c: cheek. s: outer spherical gland. l: the shaded circular line indicates extent of lumen. vs: vascular strand. gh: glandular hair.

(NOTE.—Soaking bladders overnight in 20 per cent citric acid solution assists considerably in cleaning them from soil, detritus, algae, etc.)

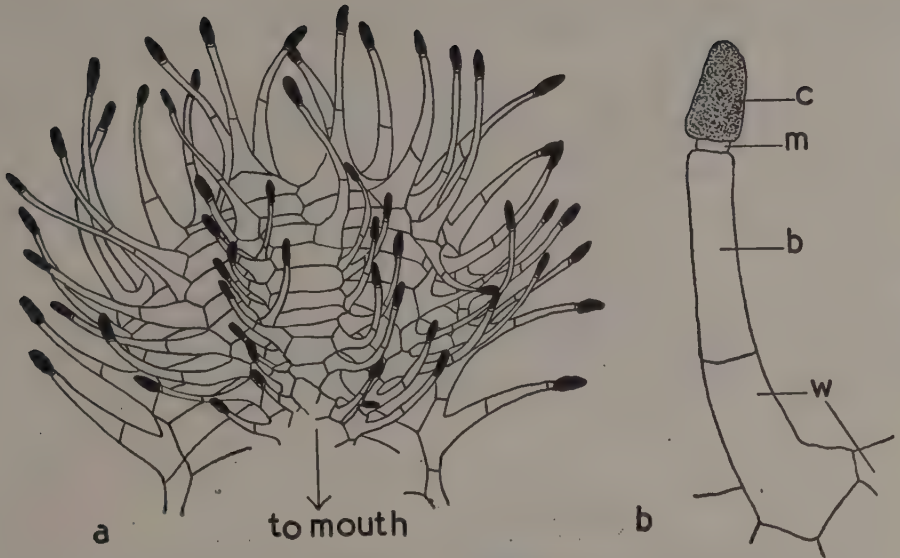


FIG. 12 (a).—Upper lip of bladder seen from below.

(b).—A single glandular hair from lip of bladder.

w: "wall cell". b: basal cell. m: middle cell. c: capital cell.

interlocking positions of these glandular hairs probably serve two functions: (a) they form a protective covering to the mouth and prevent soil particles and detritus from clogging the entrance; (b) they assist in maintaining a continuous film of water around the trap mechanism.

the mouth. Water is essential to the proper functioning of the trap mechanism.

There are no antennae or bristles (Lloyd, p. 233) on the lips of the bladder of *U. transrugosa*.

The bladder wall is composed of two layers of cells except in the lip region where it becomes thicker. The outer wall layer is continuous with the epidermis of stolon or leaf. Scattered over this outer layer are the small, 3-celled, spherical glands which are present over the rest of the underground plant (see Fig. 7). The cells of this layer are elongated along the profile of the bladder (Fig. 11) and are smaller and compressed in the cheek region, but become more equidimensional and wavy-walled on the

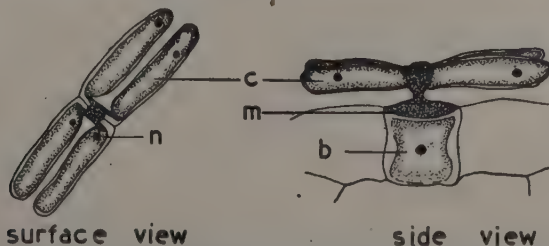


FIG. 13.—Quadrids in surface and side view.

c: projection of capital cell. m: middle cell. b: basal cell. n: nucleus.



flattened sides of the bladder. These irregular walls may assist in retaining bladder shape during action and resetting of the trap when the sides are alternately convex and concave.

The cells of the inner wall layer are in general larger in surface area than the outer wall layer cells. In the lip and cheek region the two layers are separated by one to many, large, thin-walled parenchymatous cells. The two walls enclose a central cavity or lumen which is reached from the outside through the mouth.

A single vascular strand passes into the bladder through the stalk, travels dorsally in the wall layers without branching, and finally terminates in the tissue of the upper lip.

Projecting into the lumen are glandular hairs bearing two or four armed capital cells. Darwin called them bifids and quadrifids (1888). The bifids are limited to the mouth region. Each gland arises from a cylindrical basal cell and has a disc-shaped middle cell, and a 2- or 4-armed capital cell which is devoid of cuticle. The arms of the quadrifids are equal in length and are not spreading (Fig. 13).

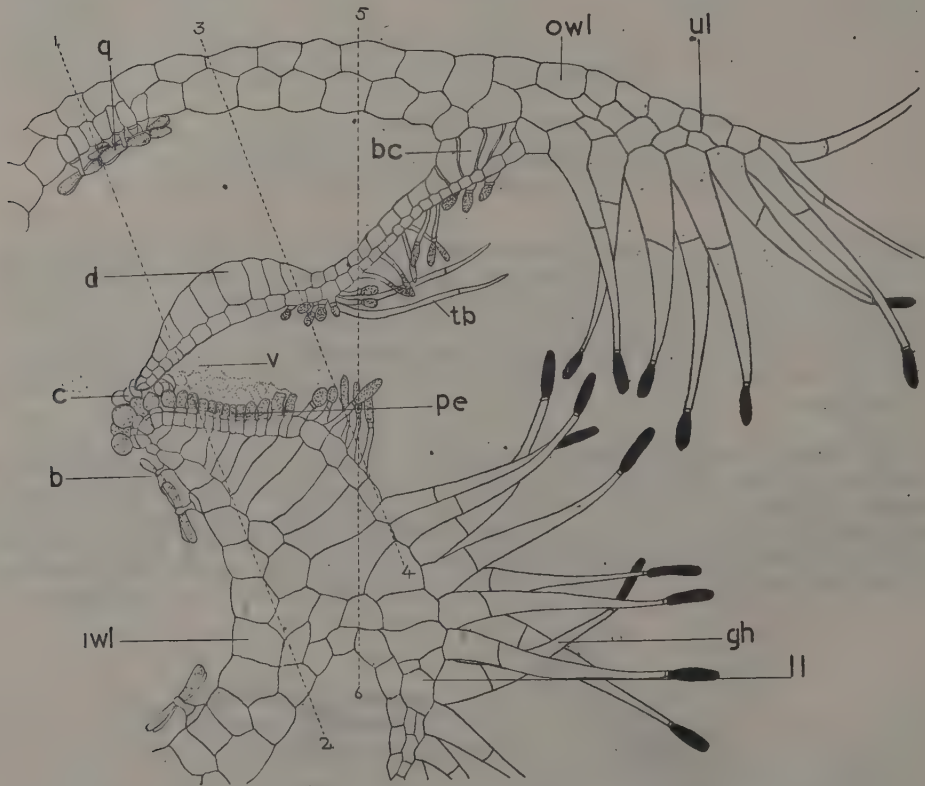


FIG. 14.—Longitudinal section through mouth region of bladder.

owl: outer wall layer. iwl: inner wall layer. q: quadrifid. b: bifid. d: door. v: theoretical position of velum. pe: pavement epithelium. c: balloon-like cuticles. ul: upper lip. ll: lower lip. gh: glandular hair. tb: tripping bristle. bc: buttress cell.

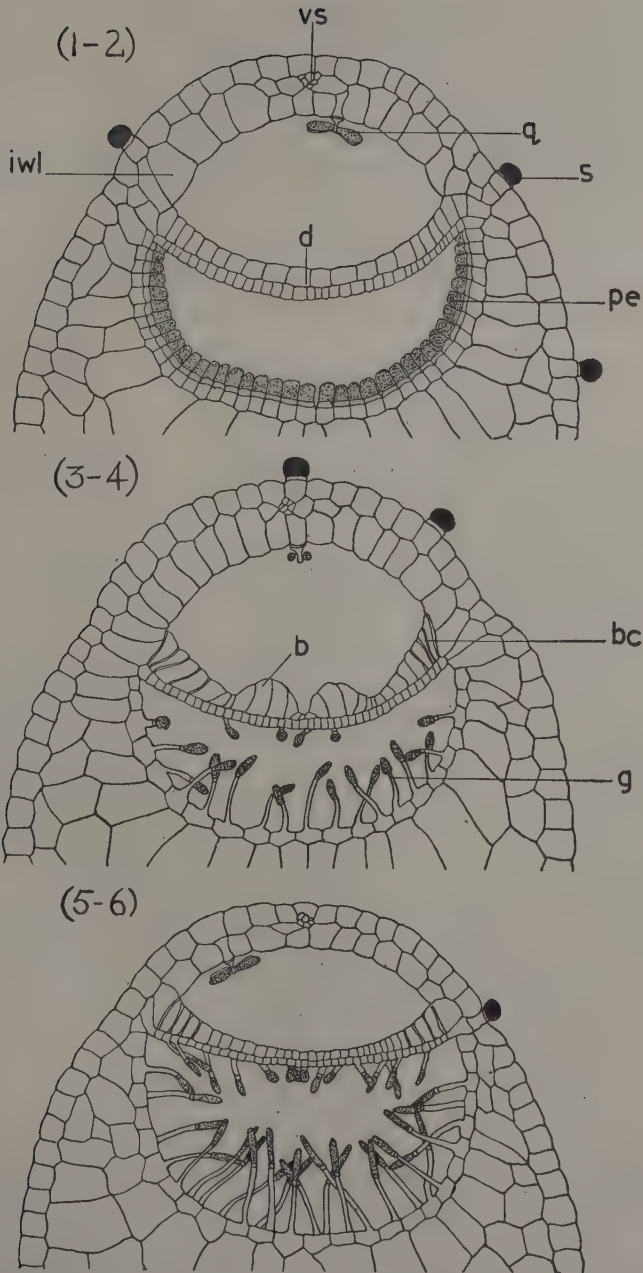


FIG. 15.—Sections through bladder along the lines 1-2, 3-4, and 5-6 of Fig. 14.

vs: vascular strand. q: quadrifid. s: outer spherical gland. pe: pavement epithelium. iwl: inner wall layer. d: door. g: gland on threshold.

The basic structure of the mouth region can be studied from Figs. 14, 15 and 16. In longitudinal section it will be seen that the upper and lower lips project beyond the rest of the bladder and that they are several cells in thickness. The lower lip also extends back in towards the lumen of the bladder as a wedge-shaped shelf—the collar or threshold. The bladder entrance is guarded by two valves; a larger one, the door, hanging obliquely inwards at an angle of  $45^\circ$ , and a smaller one, the velum. The door is an oval flap of tissue which hangs downwards from the inner margin of the upper lip. Its base rests against the threshold (Fig. 14). In its upper half, the sides of the door are attached to the cheeks, which are the flaps of tissue connecting upper and lower lips. In its lower half, the sides of the door are attached to the “pavement epithelium” (of Goebel), which is a glandular layer arising from the threshold. In this way the cheeks and pavement epithelium form a tunnel-like entrance with the door hanging obliquely across the tunnel and being attached on all sides except at the base.

The angle at which the door hangs downwards is about  $45^\circ$ , and this together with the general structure of the mouth region, classifies the bladder of *U. transrugosa* as one of the “long tubular entrance” type of Lloyd (p. 258).

From Fig. 15 it will be seen that the door in transverse section is not flat but it hangs like a hammock, the concave side being towards the upper lip, the convex side towards the lower lip. Fig. 14 shows the door in longitudinal section. It is evidently curved in this plane also.

In lower surface view, Fig. 16, it will be seen that the door is roughly oval in shape with the lower free edge truncated and appearing slightly concave due to flattening of the door in making the preparation for Fig. 16. Two distinct regions are visible; an upper and a lower. The lower half of the door is composed of small, thin-walled cells and is non-glandular. Cells in the upper half of the door are somewhat large and bear numerous glands. These glands radiate outwards from a central point where they are very short, and are also found on the invaginated cheeks and on the inside of upper and lower lips where they are much longer. The glands are slightly different in structure from other glands of *U. transrugosa* in that they are “sessile” i.e. the normal basal cell is lacking, and they arise directly from prolongations of the cells which produce them. The capital cells of these glands in the central region of the door are small and spherical, but in the upper and outer regions of the door they are greatly elongated. From the central point at the junction of upper and lower halves of the door and from which the glands radiate outwards, arise two long, stiff, tapering bristles. Very rarely, three of these bristles were seen. They form the tripping mechanism. Each bristle is of two cells, the upper being much smaller than the lower, and the lower cell arising directly from the door without any bulbous swelling at its base. These bristles in all cases, projected outwards and upwards towards the upper lip.

In longitudinal section (Fig. 14) the door is seen to consist of two layers of cells; an outer one from which the glands and tripping bristles arise, and an inner layer of cells. Two distinct regions of the door are again visible; an upper glandular, and a lower non-glandular region. In the upper portion, cells of the inner layer are slightly broader than outer layer cells (in a ratio of about 2:1) and are similarly deeper, except at the point of attachment of the door to the upper lip where cells of the inner layer are about three times as deep as the outer layer cells. In the central region of the door the cells of both layers are approximately equidimensional.

The lower non-glandular portion of the door has a characteristic and peculiar structure, similar to that found in *U. kirkii* Stapf. (Lloyd, p. 232, 260, Plate 33.) Cells of the inner door layer are greatly enlarged and form two lateral bulges separated by a narrow groove (Fig. 15). In Fig. 14 one of these bulges is shown in longitudinal section.



The door is attached to the rest of the bladder along a semicircular line, and considerable stress is placed on cells along these lines of attachment during action of the trap.

This is compensated for by the presence of thickened "buttress" cells in the inner layer of the door. These buttress cells are shown in surface view in Fig. 16. They are visible because of transparency of the outer cell layer of the door. It was not possible to confirm Lloyd's interpretation of these "buttress" cells. He states that "the cells are constricted at regular intervals" and that the spaces between the

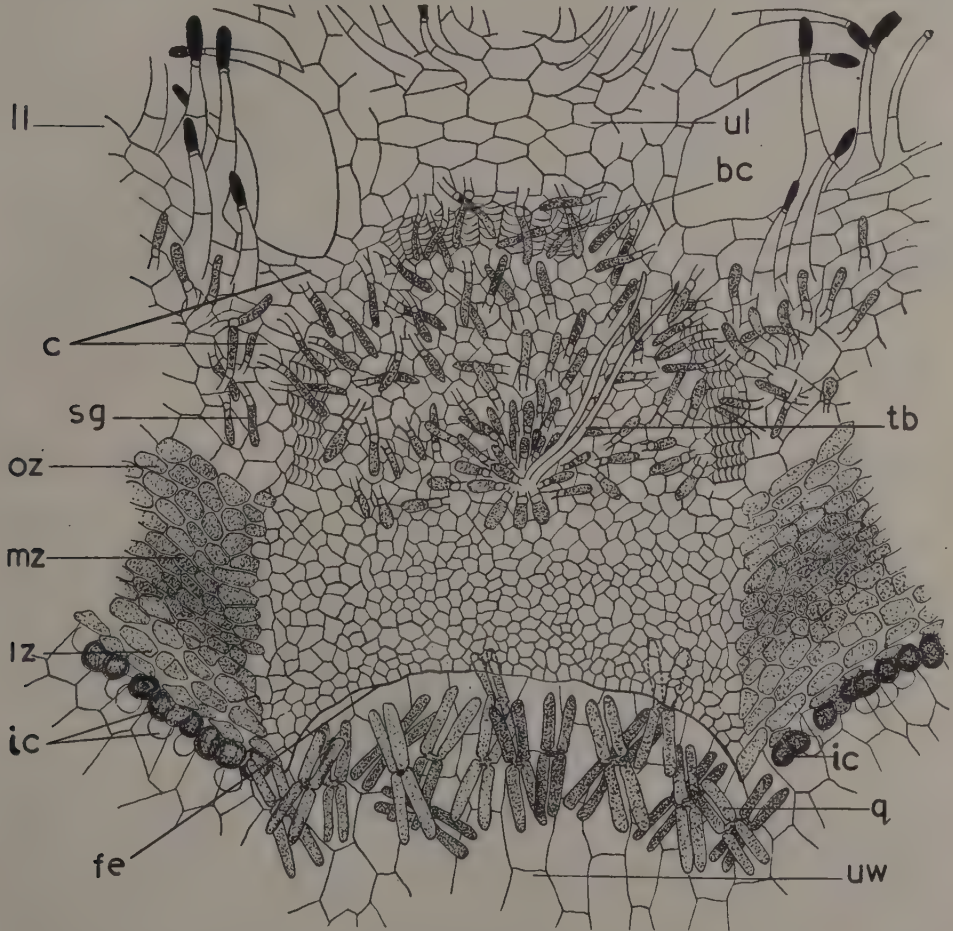


FIG. 16.—Door of bladder in lower surface view.

This preparation was obtained by slitting the threshold along a median line and spreading it out on either side of the door. This was then viewed flattened back against the upper wall and lip of the bladder.

ll: lower lip. c: cheek. sg: sessile gland. oz, mz, iz: outer, middle and inner zones of pavement epithelium. ic: balloon-like cuticles from inner zone. fe: free edge of door. uw: upper wall of bladder. q: quadrifid. tb: tripping bristle. bc: buttress cell. ul: upper lip.

constrictions are mistaken for single cells. (See Lloyd, p. 250 and Plate 33, No. 2.) Microtomed sections failed to confirm this and the view is expressed that these are indeed single cells. They are shown in transverse and longitudinal sections in Figs. 15 and 14. Buttress cells are not found where the door is attached to the pavement epithelium.

The pavement epithelium is a glandular layer arising from the threshold. The glands of the pavement epithelium are also sessile in that their lowermost cells are the outer layer of the threshold, and a true basal cell is lacking. In Fig. 14 it can be seen that these glands are tightly packed together in the central region, becoming wider spaced and separated from each other at either end. Three zones are thus distinguishable; an outer, middle and inner zone.

The velum described by Lloyd (p. 247) was not seen intact during these investigations. Its theoretical position has been indicated by dotted lines in Fig. 14. The velum is formed by the cuticles which are shed from the capital cells of the pavement epithelium glands. These cuticles remain attached to one another and to the capitals of the outer zone glands, and form a thin membranous flap which covers the free edge of the door. It is only the cuticles of the outer and middle region glands which form this velum, while those from the inner zone of glands behave individually. These enlarge and burst forming a cushion of balloon-like tissue which blocks the small chink between the edge of the door and the pavement epithelium glands. These were observed and have been represented in Figs. 14 and 16.

Thus it may be seen that the bladders of *Utricularia transrugosa* are structurally and anatomically complex. This allows for the intricate mechanism of trap action, which has been fully described by Lloyd.

## POINTS OF BIOLOGICAL INTEREST.

### (a) PERENNATION.

It has been established during these investigations that *U. transrugosa* is perennial under field and laboratory conditions.

A block of earth, about 10 inches  $\times$  10 inches  $\times$  10 inches was dug from the vlei where *U. transrugosa* has previously been collected. At the time of removing the earth (May, 1952) there were no visible signs of the presence of the plant on the surface of the vlei. The earth was kept in the laboratory at room temperature (24–28°C.) and was watered daily with tap water. No artificial nutrients were supplied to the soil. After two months (July, 1952) the plant had not reappeared in the vlei, but small green leaves appeared on the surface of the soil which had been kept in the laboratory. The plant from which these leaves were produced was then dissected free of soil. A considerably thickened stoloniferous structure was noticed, and from this arose "new" stolons bearing young green leaves. Clinging to the thickened portion were the remains of old, decayed stolons and leaves. The regular branching previously described for *U. transrugosa* Stapf was not evident in this perennating portion of the plant. As thickened structures were not found to be present in dissections of mature flowering plants, one may assume that as the young plants establish themselves they either break away from the thickened portion or this shrivels due to depletion of food reserves. Plants grown in this way in the laboratory did not develop rhizoids and all the bladders present were empty. Thus all nutrients for the developing plant must have come from the thickened stoloniferous portion or have been absorbed from the soil through the non-cuticularised capitals of the spherical glands.

Under field conditions, too, similar thickened perennating parts of the plant were found. A very young plant of which only the tips of the leaves were visible, was taken from mud along the banks of a stream and dissected free of soil and detritus. Fig. 17 shows two of the thickened areas found on this plant. It was noted that young stolons arising from these thickened parts were green, especially at the rounded growing

apices. The preparation from which Fig. 17 was drawn was left soaking in tap water in the laboratory for two weeks, after which time the small green outgrowth (Fig. 17, z) had developed from one end of the thickened portion.

The ability to develop perennating structures is not an uncommon phenomenon among the Utricularias. *U. globulariaefolia*, a fairly large terrestrial species, becomes perennial by its stout, tough stolons, similarly to *U. transrugosa*. In *U. volubilis* the plant body is an upright corm which grows at the top and dies behind. From the corm are produced numerous leaves. Wager (1928) described the ability of *U. stellaris* to form resting buds towards the end of a season. These buds were then able to develop the following spring. Many species of Utricularia have now been found to produce resting buds and the structural differences of these buds have been used as a basis for classification of the species (Rössbach, 1939).

#### (b) GERMINATION.

All efforts to germinate seeds of *U. transrugosa* were unsuccessful. Seeds were selected, and sterilised by soaking for 2 mins. in mercuric chloride (0.1 per cent in 50 per cent alcohol). They were then washed in sterile distilled water and left to soak overnight under sterile conditions.

Seeds were then placed on moist sterile filter paper, or on agar in petri plates, 10 seeds per plate, and were kept in the laboratory at room temperature which fluctuated between 24–28 C. Two kinds of agar were used; Difco bean pod agar which had

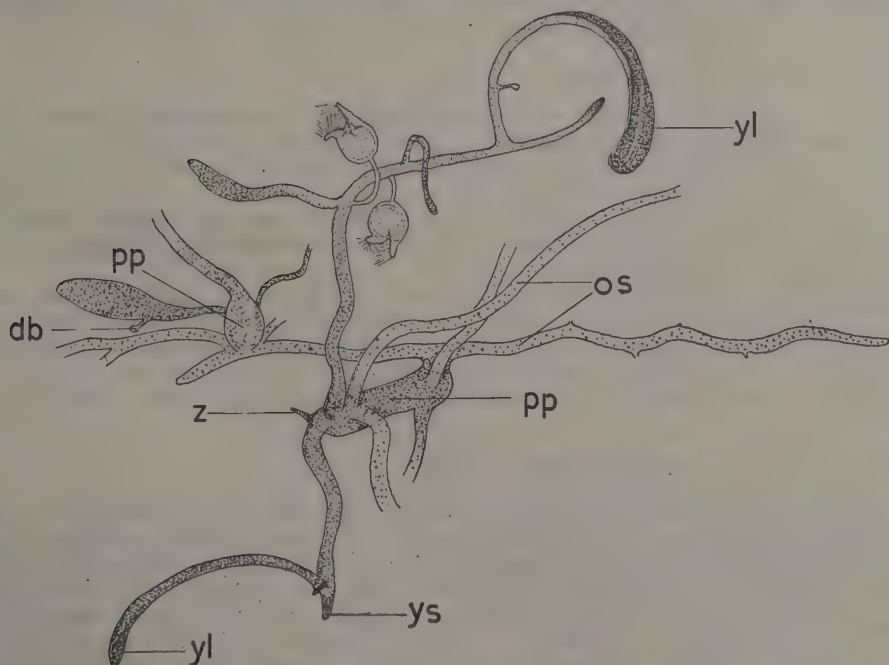


FIG. 17.—Portion of perennating plant of *U. transrugosa* Stapf.  
(Taken from natural habitat.)

The density of stippling is proportional to the greenness of the plant areas.  
pp: perennial portion. yl: young leaf. ys: young stolon. os: old stolon.  
db: developing bladder. z: young green shoot (see text).



a final pH of 5.3, and a second medium prepared as follows: 150 g soil, taken from the vlel in which the plants had been found growing, was thoroughly shaken up with 150 ml distilled water, and left to soak for 3 hrs. The suspension was then filtered and 2 per cent agar was added to the liquid obtained. The final pH of the medium was between 4.6-4.8.

It was expected that as the plants grew in acid soils, media having low pH values would be conducive to the germination of seeds. Unfortunately no definite reason is known for the failure of germination.

### (c) POLLINATION.

The manner in which pollination is effected in *U. transrugosa* can only be conjectured. The floral characteristics of the plants are highly suggestive of adaptations to cross-pollination by insects. The colour of the flowers together with their honey-like scent would act as a lure to insect visitors, which would then be directed toward the mouth of the flower by the conspicuous transverse rugosities. In entering the mouth of the flower the insect would brush against the broad upwardly facing stigmatic lobe, and on continuing downwards into the spur of the flower it would collect pollen from the anthers. It is of interest, that if the upper corolla lobe is slightly depressed (as by the entry of an insect) the anthers are drawn away from the mouth of the spur and face obliquely upwards thus being in a position which makes it impossible for an insect to enter or lave the spur without contacting the anthers.

In retreating from a flower the insect would brush the non-receptive underside of the stigmatic lobe and self pollination would be avoided.

### (d) VARIATION IN NATURE.

Several instances of variation within the species *U. transrugosa* have already been given and need only be summarised here. The most conspicuous variation occurs in flower size and colour, the purple flowers being generally the larger. The apical margin of the upper corolla lip varies in shape.

Vegetative structures are more constant however, the only variations that have been noted being the length of bladder stalk, and the presence of 2 or 3 tripping bristles on the door of the bladder.

Kamienski (1895) and Oliver (1867) have both noted a wide range of variation in floral characteristics within the species of *Utricularia*. This variability is of importance when one studies the characteristics which are used to distinguish species of *Utricularia* especially in the case of *U. livida*, *U. transrugosa* and *U. kirkii* or in the case of *U. capensis*, *U. brachyceras* and *U. ecklonii*. This will be treated more fully in the following discussion.

### (e) FOOD OF *U. TRANSRUGOSA* STAPF.

If one accepts that *Utricularias* obtain or supplement their nitrogenous food requirements by the capture and digestion of animal prey, for which processes water is essential, the survival of *U. transrugosa* in an acid semi-dry vlel is interesting. Examination of bladders from this plant, however, showed that although soil water content was so low, the bladders were functioning efficiently. Decayed animal remains were found in most bladders and appeared to consist generally of small arthropod larvae, crustaceans and nematodes. In some cases prey was extracted alive from the bladders.

An attempt to grow *Utricularias* in the laboratory was only partially successful. The plants were kept in a trough containing peat and large quartzite pebbles, and were watered regularly. The water was taken from an outdoor alga-tank which contained abundant small animal and plant life. The *Utricularias* remained alive, but only one plant produced an aerial stem, which however failed to bear flowers even though watered with beef extract solution.

## (f) PHENOLOGY.

*U. transrugosa* has a relatively short flowering period (about 3 weeks) and its time of flowering is largely dependent on adequate early summer rains. The plant was collected at Bryanston in September, 1951, after good rain, but in 1952 two flowering periods were noticed. In August and September 1952, a very dry period, isolated dwarf specimens were collected from the vlei and stream at Bryanston. Later in the year (November), after rains had fallen, flowers were again collected from the stream locally. Unfortunately, the vegetation covering the original vlei was burnt between September and November and the vlei has now completely dried out. *U. transrugosa* did not reappear in this site, even after heavy rains, and whether its disappearance is temporary or not cannot be told until the following summer.

It was evident that the long dry period in 1952 had a deleterious effect on the flowering of *U. transrugosa*, which had flowered far more abundantly in 1951.

## DISCUSSION.

The most striking point arising out of these investigations is the anatomical and morphological similarity between *U. transrugosa* Stapf and *U. kirkii*, Stapf. In his analysis of the genus in Flora Capensis, Stapf separates the two species by flower size, *U. kirkii* being considerably smaller, and by the presence of rugosities on the palate of *U. transrugosa* contrasted with the minute tubercles in *U. kirkii*. However, as many species of *Utricularia* show variation in flower size, the only tangible difference between *U. transrugosa* and *U. kirkii* is the presence of rugosities or tubercles on the palate. That this is the principal difference is further substantiated by Lloyd, whose figure illustrating the bladder of *U. kirkii* shows this structure to be almost indistinguishable from the bladders of *U. transrugosa*, described in this report. Both species are terrestrial, and Fig. 1 shows that they have been recorded from similar localities i.e. in the Transvaal, and a short distance from the Zambesi in Central Africa. Lloyd, (p. 260) has further stated, with regard to the bladder, that "*U. kirkii*, occurring in Central Africa, is apparently unique". Also (p. 232) "*U. kirkii* is an African species with apparently few associates if any, and has a distinct form of trap". The two lateral bulges formed by the inner cells of the door (called tubercles by Lloyd), have not yet been described for any other species. Bladders of *U. transrugosa* and *U. kirkii* are also similar in that they lack a "doorstep" at the point where the lower lip turns inwards to produce the pavement epithelium. In other species of *Utricularia*, the lower lip forms a non-glandular, flat, steplike ridge of tissue leading to the pavement.

Two alternatives present themselves either: (a) *U. transrugosa* is a large flowered form of *U. kirkii*, or (b) the two species are a vicarious pair.

The earlier identification of *U. transrugosa* as *U. livida* var. *transrugosa* leads one to consider the differences between the two species *U. livida* and *U. transrugosa*. Again it is found that the distinguishing features are corolla size, and the presence of tubercles on the palate of *U. livida* and of rugosities in *U. transrugosa*. Unfortunately no details of bladder structure are available for *U. livida*. If bladders were examined and found to conform to the *U. kirkii/U. transrugosa* type, an interesting position, worthy of further investigation, would arise. *U. exilis* Oliver from Flora of Tropical Africa (Fig. 1, F) which is very similar to *U. kirkii* and has a smooth palate, is of the same affinity also.

Miss L. Stevens (1938) attempted to unravel the relationship between the species *U. capensis/U. brachyceras/U. ecklonii*. Stapf (1904) maintained that *U. brachyceras* was a short spurred form of *U. ecklonii* and that *U. capensis* was a distinct separate species. Miss Stevens implies, however, that *U. ecklonii* is a growth form of *U. capensis* and should be sunk in that species' while *U. brachyceras* is quite distinct from the combined *U. capensis—U. ecklonii*. Her opinion is based on relative sizes of the stigmatic lobes.

The work of Lloyd, however, has made it obvious that in cases of close floral similarity, differentiation of species cannot be based on floral characteristics alone. The pattern of branching and bladder structure are sufficiently constant and different between species, to be used as features for taxonomic classification.

Although Lloyd does not refer to *U. transrugosa*, his descriptions of bladder types occurring among the genus *Utricularia* have proved useful guides.

### SUMMARY.

A morphological and anatomical description of the floral and vegetative characters of *Utricularia transrugosa* Stapf is given.

Anatomical details of the bladder place it in the "long tubular entrance" group of Lloyd, and show a striking similarity between *U. transrugosa* and *U. kirkii* Stapf.

Biological findings indicate that *U. transrugosa* is perennial, and like many *Utricularias* shows considerable variation in flower size and colour.

### ACKNOWLEDGEMENTS.

The writer is grateful to Professor N. P. Badenhuizen for permission to carry out these investigations in the Botany Department, University of the Witwatersrand, and to Dr. H. B. Gilliland for his constant guidance and assistance in collecting material.

The Chief, Division of Botany, and the Director, Transvaal Museum are thanked for the use of the facilities of the National Herbarium and of the Transvaal Museum respectively.

### BIBLIOGRAPHY.

- COMPTON, R. H. . . . . 1909. The Morphology and Anatomy of *Utricularia brachiata*, Oliv. New Phytologist 8, 117.
- DARWIN, C. . . . . 1888. Insectivorous Plants (London).
- KAMIENSKI, F. . . . . 1902. *Utricularia* in Bot. Jahrb. 33, 92.
1897. *Utricularia* in Engler-Prantl. Natur. Pflanzen. IV Teil IIIb abt., 118
- Lloyd, F. E. . . . . 1942. The Carnivorous Plants (Waltham, Mass.).
- METCALFE, C. R., AND  
CHALK, L. . . . . 1950. Anatomy of Dicotyledons, 2, 993.
- OLIVER, D. . . . . 1867. African Lentibulariae. J. Linn. Soc. 9, 153.
- ROSSBACH. . . . . 1939. Winter buds among *Utricularia*. Rhodora 41, 114.
- SOLREDER, H. . . . . 1908. Systematic Anatomy of Dicotyledons, 1, 694.
- STAPF, O. . . . . 1904. Lentibulareaceae in Fl. Cap. (London) IV. 2, 429.
- STAPF, O. . . . . 1906. Lentibulareaceae in Fl. Trop. Afr. (London), IV. 2, 468.
- STAPF, O. . . . . 1931. Lentibulareaceae in Fl. W. Trop. Afr. (London) 2, 232.
- STAPF, O. . . . . 1916. *Utricularia papillosa* Stapf. Kew Bull. 41.
- STEVENS, E. L. . . . . 1938. Notes on three South African *Utriculariae*. Journ. S.A. Bot. Roy. Soc. S.A. 16, 191.
- WAGER, V. A. . . . . 1928. Notes and descriptions of a Few Uncommon Water Plants. Trans. Roy. Soc. S.A. 16, 191.
- WEINTROUB, S. . . . . 1933. A Preliminary Account of Aquatic and Sub-aquatic Vegetation and Flora of the Witwatersrand. J. Ecol. 21, 44.



# The Nomenclature of Species of *Allophylus* in South Africa.

By

B. de Winter.

No complete revision of the African species of the genus *Allophylus* has been attempted since Radlkofer published his monograph of the Sapindaceae in Engler's Pflanzenreich in 1932-1934. The nomenclature adopted in the latter work is not in agreement with the latest edition of the Int. Code of Bot. Nomenclature (1952). This note is an attempt to clear up the confusion existing re the use of the correct names and also the correct citation of authors. Fortunately, name changes were found to be unnecessary except in two species.

1. *Allophylus decipiens* (Sond.) Radlk. in Engl. & Prantl. Pflanzenfam. 3 (5) 313 (1895).

*Rhus spicatum* Thunb. Fl. Cap. 11, 217 (1818).

*R. decipiens* E. Mey. in Drege Cat. Pl. Exsicc. Afr. Austr. Febr. 1839; Arnott\* in Hook. London Journ. Bot. 3, 153 (1841). nomen nudum.

*Schmidelia decipiens* (E. Mey.) Presl. Bot. Bemerk. 41 (1844) nomen nudum.

*S. decipiens* Sond. in Harv. et Sond. Fl. Cap. 1, 239 (1860).

*Allophylus spicatus* (Thunb.) Fourcade in Trans. Roy. Soc. S. Afr. 21, 100 (1932), non *A. spicata* (Poir.) Radlk. in Engl. & Prantl. Naturl. Pflanzenfam. 3 (5), 312 (1895). This species was misidentified by E. Meyer as *Rhus undulata* Jacq.

2. *Allophylus dregeanus* (Sond.) de Winter, comb. nov.

*Rhus monophylla* E. Mey. in Drege, Zwei Pflanzengeogr. Doc. 216 (1843), nomen nudum.

*Schmidelia monophylla* (E. Mey.) Presl. Bot. Bemerk. 470 (1845) nomen nudum, non Hook. f. in Hook. Icon. t. 775 (1845).

*S. dregeana* Sond. in Harv. et Sond. Fl. Cap. 1, 239 (1860).

*S. monophylla* var. *natalitia* Szyszyl. Enum. Polypet. Rehmann 2, 47 (1888).

*Allophylus monophyllus* Radlk. in Engl. et Prantl. Naturl. Pflanzenfam. 3 (5), 312 (1895). nomen nudum, et in Engl. Pflanzenr. 4, 165. 518 (1932).

3. *Allophylus melanocarpus* (Sond.) Radlk. in Engl. et Prantl. Naturl. Pflanzenfam. 3 (5), 313 (1895).

*Rhus melanocarpa* E. Mey. et *Rhus leucocarpa* E. Mey. in Drege Cat. 3 (1840); Arnott in Hook. Journ. Bot. 3, 153 (1841); Meyer in Drege, Zwei Pflanzengeogr. Doc. 216 (1843), nomina nuda.

*Schmidelia melanocarpa* Sond. in Harv. et Sond. Fl. Cap. 1, 238 (1860).

*S. leucocarpa* Sond. l.c.

*S. rehmanniana* Szyszyl. Polypet. Rehmann. 2, 46 (1888).

\* Arnott has often been cited as the author of this species. A short description is given by him when contrasting the species with *Rhus melanocarpa* and *Rhus erosa* E. Mey. non Thunb. The short insufficient diagnosis is not valid, however, since Arnott still uses *Rhus* as the generic name although he points out that the plants belong to the genus *Schmidelia*. (See Art. 43, Int. Code of Bot. Nomenclature, 1952). The same applies to *Rhus melanocarpa* and *Rhus leucocarpa*. Sonder (in Fl. Cap.) gives good descriptions and the names must be attributed to him.

4. *Allophylus natalensis* (Sond.) de Winter comb. nov.

*Schmidelia natalensis* Sond. in Harv. et Sond. Fl. Cap 1. 239 (1860).

*A. erosus* Radlk. in Engl. Pflanzenr. 4, 165, 544 (1932).

This species was validly described for the first time by Sonder who gave it the name *S. natalensis*. Earlier, the species had masqueraded under the illegitimate name "*Rhus erosus*, E. Mey." The origin of the latter name is plainly a misidentification which can be traced to E. Meyer who in the various works on Drege's plants named this species as *Rhus erosus* Thunb. When it was realized that the latter was a distinct species subsequent authors used the name *Rhus erosus* E. Mey. non Thunb.

Radlkofer recognized this fact and to rectify the error described *Allophylus erosus* Radlk. as an independent species based on the plant misidentified by E. Meyer as *Rhus erosus* Thunb. This would have been legitimate had there been no other name available.

The following species complete the list of members of the genus *Allophylus* recorded for South Africa.

5. *Allophylus transvaalensis* Burt Davy in Kew Bull. 280 (1921).

This is probably only a hairy variety of *A. melanocarpus* (Sond.) Radlk.

6. *Allophylus gazensis* Bak. f. in Journ. Bot. 57. 182 (1919).

Galpin 909, Lakwongwa Forest, Barberton, Transvaal; matches the type of *A. gazensis* in Kew.

# The Nomenclature of the Cape Acacia.

By

I. C. Verdoorn.

By the "Cape Acacia" is meant the species which occurs naturally and abundantly to within about 75 miles of Cape Town. It is the only *Acacia* species in that region but is not restricted to the Cape and further to the north and east other species of *Acacia* occur as well. The early travellers such as Barrow, Lichtenstein, Sparrman, Thunberg and later Burchell make mention of this *Acacia* for it is a feature of the landscape in the Hex River Pass and in quite a wide radius from that point to the interior.

Besides the common name "Cape Acacia" it is also known as the "Karoo Thorn", "Cape Thorn Tree", "Doring Boom", "Witdoring" or "Mimosa". In the Transvaal it is commonly called "Sweet Thorn" or "Soetdoring". According to Simon van der Stel's Journal the Namaquas name for it was "Choe" while in Natal the Zulus call it "UmuNga".

The species is characterised by the following features: the habit of growth varies from shrubby thickets to tall, well-shaped trees, all armed with long, straight, white, paired spines; the sweetly scented flowers are yellow (the colour of egg yolk), massed in small globose heads which are axillary in the upper leaves and run into leafless panicles at the apex of the branchlets; the leaves are only 2 to 5 jugate with comparatively large leaflets; and the pods are linear and sickle shaped.

The following is an account of the botanical name and synonyms of this plant.

*Acacia karroo* Hayne Arzneyk. Gebr. Gewachse 10, descr. et t. 33 (1827); Glover in Ann. Bol. Herb. Vol. 1, p. 150 (1915); Burt Davy in Kew Bull. 1922 p. 328 and in Tvl. Fl. 2, p. 346; Marloth in Fl. of S.A. 2, p. 51 (1925); and Baker in Leg. of Trop. Afr. p. 843 (1926).

*Mimosa nilotica* Burm. f. Fl. Cap. p. 27 (1768); Thb. in Fl. Cap. Ed. Schult. p. 432 (1823) non Linn.

*Mimosa capensis* Burm. f. 1. c. p. 27 (1768) partly.

*Mimosa leucacantha* Jacq., Hort. Schoenbr. 3, 75 (1798-1800) non Vatke.

*Acacia horrida* Willd. Sp. Pl. (1805) as to Jacq. fig.; Harv. and Sond. in Fl. Cap. 2, 281 (1865).

*Acacia capensis* (Burm.) Burchell. Trav. 1, p. 114 and 189 (1822); Sw. in Hort. Britt. 1, 103 (1826) nomen; Colla in Mem. Acad. Torin 35 p. 175 (1831); Eckl. and Zeyher Enum. Pl. Afr. Aust. 260 (1835) nomen.

*Mimosa eburnea* Bojer Hort. Maurit. 115 (1837) non Linn.

*Mimosa nilotica* Burm. f. For this species Burman quotes Plukenet t. 123 fig. 1 and mentions that there are dried specimens and other figures of it. Plukenet t. 123 fig. 1, although showing only a leafy twig, could very well represent the "Cape Acacia." The leaflets are too big for *Mimosa nilotica* L. and besides it is known that that species does not occur near the Cape. Through the kindness of Prof. Baehni, Director of the Conservatoire et Jardin Botaniques, Geneva, photographs of the only two *Acacia* specimens in Burman's herbarium were received. The one specimen has written on it "*Mimosa nilotica* Linn" and "Plukn. Tab. 123. Fig. 1." (the name *Mimosa capensis*





FIG. 1.—Photo of *Acacia* specimen in Burman's herbarium, Geneva. Sent by Prof. Baehni in July, 1952.

was later written over *Mimosa nilotica*, see our Fig. 1. As far as one can tell from a leafy twig this also represents the "Cape Acacia".\* So *M. nilotica* was a wrong identification by Burman of the "Cape Acacia".

The same is true for *Mimosa nilotica* Thunb. Barrow made this clear when he wrote in his "Travels" p. 89 (1801) "... skirted by a thicket of the doornboom or thorn tree, a species of Mimosa, called erroneously by the Swedish travellers (Sparman and Thunberg) the nilotica, or that which produces the gum Arabic. The pods of this are very long and moniliform . . . whereas the Karroo Mimosa has short sickle-shaped pods". The sickle-shaped pod of our Acacia is the characteristic by which it can be distinguished from other related species in S.A., Egypt, Asia, and India.

*Mimosa capensis* Burm. f. In this case Burman quotes only Plukenet t. 123 fig. 2 (see right hand figure reproduced here under our Fig. 2), and he does not mention dried material. This figure is not recognisable as the "Cape Acacia" nor indeed as any S. African species of *Acacia*. It is true that the same figure, somehow got into the "Van der Stel's Journal of the Expedition to Namaqualand 1685-6" published by Waterhouse in 1932 and is supposed to represent the Acacia met with on that expedition which from description and locality probably was the "Cape Acacia". On the other hand the same figure is quoted by Linnaeus for his *Mimosa reticulata*. Bentham in his *Mimosae* p. 507 comes to the decision that both the names based on Pluk. t. 123 fig. 2, that is *M. capensis* and *M. reticulata*, must be rejected since the figure is not recognisable and there are no dried specimens of either species. In following Bentham's decision the present author is supported by the Advisory Committee on Problems of Botanical Nomenclature and Associated Matters in South Africa, which rules that since Burman obviously did not understand the species when he published the name it must be rejected. It appears that later Burman learned of his mistake, for on the herbarium sheet where "*Mimosa nilotica* Linn." had been written the name "*Mimosa capensis*" was later written over it, as stated above (see again our Fig. 1).

*Mimosa leucacantha* Jacq. Jacquin's plate is the first easily identified figure published with a definite name but the combination of the epithet with *Acacia* is invalidated by the earlier name *Acacia leucacantha* Vatke. for an entirely different species.

*Acacia horrida* Willd. Under the name *Acacia horrida* in Sp. Pl. (1805), Willdenow cites three distinct species:—

(a) *Mimosa horrida* L. Sp. Pl. 1505 (1764).

(b) *Mimosa leucacantha* Jacq. Hort. Schoenb. 3 p. 75 t. 393 (1798).

(c) *Mimosa orfora* Forsk. descr. 177 (1775).

(a) This is the type of Willdenow's new combination. Linnaeus first described *Mimosa horrida* in Sp. Pl. Ed. 1, p. 521 (1753). Willdenow cites the description as being in Sp. Pl. Ed. 3, 1505 (1764) but since the wording is practically the same in both editions it is not significant. In both editions the species is said to be an Indian species and Pluk. t. 121, Fig. 1, is cited. So Willdenow's name must be restricted to whichever Indian species agrees with Pluk. t. 121, fig. 1.

(b) As pointed out above Jacquin's figure is of the "Cape Acacia" and different from *Mimosa horrida* L.

---

\* As a matter of interest the other specimen of *Acacia* in Burman's herbarium is that of a seedling grown from seed and cannot be identified.



FIG. 2.—Photo of Plukenet Tab. 123: Fig. 1 Quoted by Burman for *Mimosa nilotica*; also quoted by Linnaeus for *Mimosa scorpioides*; Fig. 2 Quoted by Burman for *Mimosa capensis*; also quoted by Linnaeus for *Mimosa reticulata*.

(c) *Mimosa orfota* (not *orfora* as written by Willdenow) is combined with *Acacia* by Schweinfurth in Bull. Herb. Boiss. 4, appendix 2, p. 213, 1896 and *Acacia nubica* Bth. is sunk under it. This is a species quite distinct from the "Cape Acacia".

Harvey and Sonder's use of the name *Acacia horrida* Willd. in the Flora Capensis is therefore also incorrect since Willdenow's name must be restricted to Linnaeus' specimen and cannot be applied to the Cape species.

*Acacia capensis* (Burm.) Burchell. In his "Travels" Vol. 1, p. 114, Burchell mentions the Karroo-thorn-tree at Genadendal and gives it the name *Acacia capensis* B. but he does not give a Latin diagnosis as is his custom with new species. This suggests that it may have been a new combination but nowhere does Burchell confirm this. On page 189 he describes the *Acacia* unmistakably and there is a drawing of it at the head of the chapter commencing on that page. In spite of the absence of a Latin description, this might be considered legitimately published under the provisions of articles 37 and 43 of International Rules of Botanical Nomenclature, where it is stated that in certain circumstances a plate with analysis is accepted as equivalent to a description (if the plates and names were published before Jan. 1, 1908). But in the face of Bentham's statement in *Mimosae* p. 507 this cannot be looked upon as a new



species but as a new combination. Bentham, who worked with Burchell on his Leguminosae, writes "Burchell adopted the name *A. capensis* for this species, supposing it to be the *Mimosa capensis* Burm. Cap. p. 27, which it probably is." Burchell's name is therefore the combination with *Acacia* of *Mimosa capensis* Burman and must be rejected.

*Acacia capensis* Colla. This is a doubtful species because (a) the type is a seedling grown from seed which the donor averred was that of *Acacia capensis* of the Cape of Good Hope, and (b) the description is based on Burchell's description of his *Acacia capensis*. In any case the name is redundant because as shown above the combination with "capensis" had already been published.

*Mimosa eburnea* Bojer. The Cape species was introduced into Mauritius and became naturalised there. It was erroneously identified as *M. eburnea* L.f. by Bojer and listed in his Hort. Maurit. 115 (1837).

***Acacia karroo* Hayne** is, therefore, the correct name for the "Cape *Acacia*".



## Newly Described Species.

By

L. Britten, A. Brueckner, H. B. Christian, R. A. Dyer,  
M. D. Henderson, D. J. B. Killick, R. Story,  
I. C. Verdoorn and H. Wild.

### ASCLEPIADACEAE.

*Tavaresia meintjesii* R. A. Dyer, sp. nov., affinis *T. angolensi* Welw. corollae tubo brevior lobis longioribusque, coronae exterioris lobis facile distinguitur.

*Planta* parva, succulenta cactiformis e basi ramosa. *Caules* 8–10 cm. alti, 1.2–1.5 cm. crassi, 6–8-angulati, angulis tuberculatis spinosis, spinis pubescentibus 4–5 mm. longis, plus minusve hastatis setis lateralibus 1.5–2 mm. longis. *Flores* pauci cymis sessilibus ramorum basin versus emittentes; pedicelli 1–2 cm. longi, puberuli. *Sepala* lanceolata vel lineari-lanceolata, 1–1.2 cm. longa, puberula. *Corolla* 7–7.5 cm. longa, infra medium tubulosa tubo obconico 3–3.5 cm. longo 2.5 cm. lato pilis longis induto, lobis triangulari-lanceolatis circiter 4 cm. longis, minutissime pubescentibus, pilis usque 3 mm. longis ciliatis. *Coronae exterioris lobi* basi breviter connati, 9–10 mm. longi profunde 2 vel rariter 3 segmentis linearibus supra medium recurvis divisi. *Coronae interioris loborum* cornu exteriori 2–3 mm. longum, interiore filiforme, 7–8 mm. longum.

TRANSVAAL.—Zoutpansberg Distr.: 40 m. east of Messina near n'Wanedze River, *Meintjes* (ex *Steenkamp*) 523; about 20 east of Messina near n'Jelele River, *Meintjes* (ex *Myburgh*) 663, cult. Johannesburg (type); Pietersburg Distr.: Mariepskop among rocks on koppie, *Lubbe* in Nat. Herb. Pretoria 28520.

#### PLATE 1.

A tufted dwarf perennial succulent, leafless and spinose. *Stems* branching from near the base, erect, 8–10 cm. tall, 1.25–1.5 cm. thick, glabrous or very minutely pubescent, angled; angles 6–8, tuberculate; young tubercles terminated by an ascending, pubescent, hastate-shaped bristle; bristle with a central lanceolate lobe 4–5 mm. long and with the two sharply pointed lateral lobes 1.5–2 mm. long, with margin and keel thickened. *Flowers* few in sessile cymes from near the base of young branches, developed successively; pedicel 1–2 cm. long, puberulous. *Sepals* lanceolate or linear-lanceolate, 1–1.2 cm. long, puberulous down the central portion of the back. *Corolla* 7–7.5 cm. long, tubular at the base, cream-coloured within with spots and transverse bands of maroon, and maroon on the margins; tube obconical, 3–3.5 cm. long, 2.5 cm. wide at the mouth, long-pubescent, especially towards base; lobes triangular-lanceolate, about 4 cm. long and about 1.5 cm. broad at base, spreading, minutely pubescent on surface with spreading white to red cilia 3 mm. long on margin. *Outer corona* maroon, 9–10 mm. long, united into a tube 2 mm. long at the base, each lobe deeply divided to give 10 linear segments or occasionally one or more of the lobes may produce a third central filiform segment; segments erect from the base and spreading-recurved above and slightly thickened towards apex. *Inner corona* lobes



maroon, united at the base to the tube of the outer corona, 2-horned; outer horn erect-spreading, 2–3 mm. long; inner horn filiform, erect, 7–8 mm. long.

The first record of this species in the National Herbarium dates back to 1943 when Mr. B. Meintjes of Johannesburg submitted a specimen for identification. The flower was so different in its proportions from other species of *Tavaresia* that doubt arose whether the flower was normal or not. Eventually a second specimen was located in the same area and when this too flowered in Mr. Meintjes collection in Johannesburg it proved identical to the first. In addition a specimen, which was received from the Pietersburg district, agrees sufficiently closely to the other two to be included in the same species. The species is remarkable in the genus for the shortness of the corolla tube by comparison with the length of the lobes, and the outer corona lobes, while slightly thickened at the ends, do not have the knob-like tips of the three other known species. In vegetative character it shows a close similarity to *T. angolensis* Welw.

In the type locality in the Limpopo River Valley, east of Messina, Mopane veld [*Colophospermum mopane* (Kirk ex Benth.) Leonard] is dominant. Other succulent plants in the same area include *Stapelia gigantea* N.E.Br., *S. gettleffii* Pott, *Caralluma rogersii* Bruce & Dyer and *Monadenium lugardae* N.E.Br.

### CHENOPODIACEAE.

*Atriplex erosa* Brueckner and Verdoorn sp. nov., ab *A. semibaccatae* annuis foliis valde incis marginibus involutis bracteis fructiferis latioribus plerumque tuberculatis differt.—*A. rosea* Wright in Fl. Cap. 51, p. 446 quoad Bolus 656, non Linn; *A. tartarica* Paul Aellen Bot. Jahrb. 70, 1940, non Linn.

Herba sub-lignosa, annua, erecta vel decumbens usque ad 50 cm. alta, ramosa; rami angulati furfuracei. Folia alterna, subsessilia vel breve petiolata, ovata vel ovato-lanceolata, 0.6–3 cm. longa, 0.4–1.5 cm. lata, supra leviter subtus dense furfuracea, marginibus involutis valde incis apicibus acutis basibus cuneatis. Flores monoici, glomerati; glomeruli axillares et in spicas terminales dispositi (folia subtendentia apicem versus valde reducta); superiores floribus maculinis atque paucibus ad basin femineis, inferiores floribus femineis.

*Flores masculi*: lobi perianthii membranacei, dorso carnosi, obovati, apice obtusi basi connati c. 0.1 cm. longi; stamina 5, lobis opposita, filamentis brevibus planis basi connatis, antheris dorsifixis. *Flores feminei*: 2-bracteati bracteis sub-carnosis tuberculatis; perianthium nullum; ovarium compresso-globosum; styli 2, filiformes, basi connati; ovulum 1. *Bractee* fructiferae 2, late rhomboideae vel sub-rhomboideae circiter 4 mm. longae, 3 mm. latae, fere medio connatae, basi cuneatae, apice subrotundae vel late triangulares, margine irregulariter dentatae, dorso leviter pilosae lepidotae distincte tuberculatae. Semen compresso-orbiculatum, circiter 2 mm. longum, circiter 1.7 mm. latum, nitidum, fuscum.

CAPE PROVINCE.—Middelburg Division; Grootfontein, Gill 45; Kimberley Division; Wesselton, Wilman no num. in McGregor Museum Herb; Alexandersfontein, Burt Davy 9561; Brueckner 805 (type) and 806; Aliwal North Division: Aliwal North, Derrington 2560.

ORANGE FREE STATE.—Bloemfontein Division; Bloemfontein, Potts in Herb. Grey University College, 2891; Fauresmith Division; Ventersvlei, Verdoorn 1159; Wheeldon, Henrici, 2440; Jagersfontein, Smith 5171; Knoffelsfontein, Smith 5392; Acocks 13506.



FIG. 1.—*Atriplex erosa* Brueckner and Verdoorn, 1, apical portion of flowering branch; 2, male flower,  $\times 5$ ; 3, rudimentary ovary in base of corolla tube  $\times 5$ ; 4, anther  $\times 10$ ; 5, rudimentary ovary  $\times 5$ ; 6, fruiting bracts separated, the lower showing the seed within,  $\times 10$ ; 7, larger mature fruiting bracts intact,  $\times 10$ .

*Annual herb* somewhat lignified, erect or decumbent (erect plants with a single, erect, branched stem up to 50 cm. high: decumbent usually with several decumbent stems radiating from the tap root). *Branches* angular lepidote, greenish-grey to reddish-grey. *Leaves* alternate, subsessile or shortly petioled, ovate to ovate-lanceolate, 0.6–3 cm. long, 0.4–1.5 cm. broad, ashy or mealy lepidote on both surfaces, sparsely so on upper, densely on lower surface, midrib prominent beneath, margins involute and deeply incised, apex acute and base cuneate. *Inflorescence* with flowers clustered into close terminal and axillary glomerules, the subtending leaves much reduced towards the apex; clusters of male flowers, with a few female flowers at the base, in the axils of the upper leaves and female flowers in the lower. *Male flowers* with 5-merous perianth, the lobes membranous, thickened dorsally, obovate, obtuse, more or less 0.1 cm. long, joined at the base into a short tube; stamens 5, opposite the perianth lobes, filaments short, flattened, connate at the base; anthers dorsifixed, shedding

pollen through vertical slits; ovary rudimentary, conical. *Female flowers* with two compressed fleshy, usually tuberculate bracts; perianth 0; ovary globose, compressed; styles 2, filiform, connate at the base; ovule 1, surrounded by a delicate pericarp. *Fruiting bracts* 2, broadly rhomboidal or sub-rhomboid more or less 4 mm. long and 3 mm. broad cuneate at the base, connate for about  $\frac{1}{4}$ — $\frac{1}{2}$  their length, the free apices semi-orbicular to broadly triangular and irregularly toothed, the outer surfaces slightly pilose-lepidote, with conspicuous wart-like tubercles. *Seed* round, compressed, more or less 2 mm. long and 1.7 mm. broad, smooth, shiny, dark brown.

The distribution of this plant is, according to existing records, limited to portions of the southern Orange Free State and the northern Cape Province where it flourishes in somewhat moist and brackish denuded localities. Its occurrence in restricted patches is evidently on account of it not being relished by stock, so it grows fairly vigorously and is propagated by seeds which are not carried abroad. The nature of its distribution, and the habitat leads us to assume that it is indigenous.

In South Africa the identification of *Atriplex* species has been rendered difficult by the large scale introduction of Australian species as fodder plants in the more arid and saline areas. Some of these have become naturalised and hybridization takes place.

Dr. Paul Aellen in his " *Atriplex und Blackiella in Sudafrica* " Bot. Jahrb. 1940, placed specimens which belong to the species described here under *Atriplex tartarica* L. but recently, on seeing the specimens quoted here, he agreed that they are distinct from the European species and should be described as intended by the present authors. We greatly appreciate Dr. Aellen's help and advice as he is an authority on the world's Chenopodiaceae whereas we know only our local representatives of the family.

***Atriplex suberecta* Verdoorn sp. nov.**, *A. muelleri* affinis sed bracteis in floribus femineis apicibus deltoideis basi pseudo-stipitatis incrassatis foliis non truncatis differt.

*A. muelleri* Paul Aellen in Bot. Jahrb. 70, 1940 p. 390 non Benth.

Herba annua vel perennis, basi sub-lignosa, usque 75 cm. alta, plus minusve pilis diaphanis squamuliformibus obiecta; rami decumbente-erecti, usque 1 m. longi. *Folia* oblonga, ovata vel rhomboidea, basi cuneata, breve petiolata, crasse et irregulariter sinuato-dentata vel lobata, 1–5 cm. longa, 0.5–3.5 cm. lata, plus minusve pilis diaphanis, squamiformibus obiecta. *Flores monoici* glomerati; glomeruli axillares, floribus masculinis atque ad basin paucibus femineis in axillis superioribus, femineis in axillis inferioribus dispositis. *Flores masculini*: perianthium breve tubulatum, plerumque 5-lobatum, laete viridum nonnumquam roseum; lobi c. 1.5 mm. longi; stamina plerumque 5 lobis perianthii opposita filamentis basi connatis; antherae apud apicem dorsifixae. *Pistillum* rudimentum. *Flores feminei*: bractae compressae c. 4 mm. longae, 3.5 mm. latae, basi connatae rhomboideae pilis farnaceis obiectae apicibus deltoideis dentatis basi pseudo-stipitatis incrassatis solidis. *Ovarium* compresso-globosum pericarpis membranaceis; styli 2; ovulum 1; testa crustacea. *Fructus* sub-globosus, compressus c. 3.5 mm. longus, 3 mm. latus, basi incrassatus induratus-que aliquantum osseus apicibus deltoideis bractearum persistentibus. *Semen* compresso-orbiculatum nitido-bruneum.

CAPE PROVINCE.—Oudtshoorn Div.: Oudtshoorn, Gill 37; du Plessis no num. Albany Div.: "Lakeside", Lindstedt 24; Grahamstown, Story 3741. Fort Beaufort Div.: Fort Beaufort, Taylor 1. Graaff Reinet Div.: Graaff Reinet, Sister Tarcisia 10. Middelburg Div.: Grootfontein, Verdoorn 1739; Theron 47, 48, 79. Stutterheim Div.: Bolo, Acocks 9699. Tarka Div.: Tarka Conservation Area, Whitlock 3. Calvinia Div.: Calvinia, Smith 2463; Schmidt 398. Hanover Div.: Hanover, Herb. Univ. Witwatersrand 24925. Aliwal North Div.: Aliwal North, Gerstner 157B; Henrici



3053. Hopetown Div.: Olifantskop, *Blankenburg* 2. Kimberley Div.: Kimberley, *Acocks* 743; *Brueckner* 772. Barkly West Div.: Boetsap, *Pagan* no num. Hay Div.: Postmasburg, *Esterhuysen* 1120. Prieska Div.: Prieska, *Bryant* 206.

ORANGE FREE STATE.—Fauresmith Div.: Fauresmith, Veld Reserve, waste lands, *Henrici* 3854 (type), 3860, 3860, 3855, 3855a; *Verdoorn* 1194; *Brueckner* 812; Schansen, *Verdoorn* 2206; Jagersfontein, *Smith* 5229. Bloemfontein Div.: Glen College, *Mostert* 1, 2, 3, 4, 700.

SOUTH WEST AFRICA.—Luderitz Div.: Luderitz, *Kinges* 2020. Swakopmund Div.: Swakopmund, *Moss* 6967; *Rogers* 29708; *Bradfield* 576; Nonedas, *Bradfield* 472; Palmerhorst, *Wiss* 953. Bulspoort, *Liebenberg* 5122.

TRANSVAAL.—Pretoria Dist.: Pretoria, Skanskop, *Repton* 1098. Benoni Dist.: Benoni, *Bradfield* 293, *Bradfield* 125.



FIG. 2.—*Atriplex suberecta* Verdoorn, 1, apical portion of flowering branch; 2, bracts enclosing female flower,  $\times 5$ ; 3, fruiting bracts beginning to swell and indurate at stipe-like base,  $\times 9$ ; 4, maturing fruit with bracts completely indurated except for toothed apical portion,  $\times 9$ ; 5, one bract removed showing the gynoecium,  $\times 9$ .



FIG. 3.—1, Fruiting bracts of *A. semibaccata* R. Br.; 2, fruiting bracts of *A. suberecta* Verdoorn; 3, fruiting bracts of *A. muelleri* Bth.; 4, fruiting bracts of *A. erosa* Brueckner & Verdoorn.

An annual or perennial herb, sub-woody at the base, forming a bushy growth up to 75 cm. tall, more or less scaly with diaphanous swollen-based hairs (which become scale like in dried specimens); branches decumbent erect, up to 1 m. long. *Leaves* very variable in size, shape and dentation, oblong, ovate or rhomboidal, cuneate into a short petiole, coarsely and irregularly sinuate-dentate or lobed, 1-5 cm. long, 0.5-3.5 cm. broad, more or less mealy pubescent on upper surface and scaly on lower surface. *Flowers* monoecious, in glomerules, the males, with a few females at the base, aggregated in the axils of the upper leaves and the females in the axils of the lower leaves. *Male flowers* pale green with a dark green keel (not seen on dried specimens) or occasionally suffused with red (red may be present in some flowers on the same plant); perianth tube short, lobes usually 5, about 1.5 mm. long, cucullate. *Stamens* usually 5, opposite the perianth segments, filaments linear in dried specimens, terete and turgid in fresh, united at the base about 1 mm. long; anthers attached near the apex, the cells free below. *Rudimentary ovary* present in the base of the perianth tube. *Female flowers* bi-bracteate; bracts flat, enclosing the ovule to above the middle, cuneate below and with a stipe-like base which becomes solid and swollen as the fruit matures; apical lobes with a large central deltoid tooth and with 1 or more smaller teeth on each side, pubescent with diaphanous swollen hairs, 3-nerved from the base, nerves disappearing as the fruit matures and the swelling which starts at the stipe-like base spreads upwards; ovary compressed globose with a membranous pericarp; styles 2; ovule 1, testa crustaceous. *Mature fruit* enclosed in the persistent bracts, sub-globose, compressed, becoming swollen and indurated from the stipe-like base until all but the deltoid apex of the bracts becomes smooth and somewhat bone-like, usually 3.5 mm. long and 3 mm. broad. *Seed* compressed globose, brown, shiny.

This species, which is very common in a wide area in South Africa, has for long been identified with *A. rosea* of the Flora Capensis (Vol. 5, p. 44) probably because it runs to that species in the key. In that work, however, the only specimen from South Africa cited by Wright, *Bolus* 656, as represented in the Bolus Herbarium, is the species described above as *A. erosa* Brueckner and Verdoorn (it is certainly not *A. rosea* L.).

In the article "Atriplex und Blackiella in Südafrika", Bot. Jahrb. 1940, Paul Aellen cites several specimens, which are here described as *A. suberecta*, under *A. muelleri* Bth. After seeing a large collection sent to him from the National Herbarium in 1952 Dr. Aellen wrote that he is now convinced that the South African specimens he had placed under *A. muelleri* are distinct from that species and should be described as a new species. He added that the opportunity of seeing the S. African material and notes had made him realize that similar plants occur in Europe and in Australia and that he had considered them to be the juvenile form of *A. muelleri* Bth. (see "Die in Europa wolladventiv beobachteten Australischen Atripliceen" by Paul Aellen in Verh. Naturf. Gesellschaft in Basel Vol. 50 p. 159 (with figure) and "Revision der Australischen und Neuseeländischen Chenopodiaceen" in Bot. Jahrb. 68, p. 369).

Since I have not been able to examine the specimens either from Europe or Australia, only the South African plants are dealt with here. I am grateful to Dr. Aellen for his help and advice and for encouraging us to publish the two new species.

It is hoped that in his future work on the family, as the authority on Chenopodiaceae, he will take the matter further.

The following key should help to distinguish the two new species *A. erosa* and *A. suberecta* from their nearest relatives in South Africa, *A. muelleri* Bth. and *A. semibaccata* R. Br., the Creeping Salt Bush. The two last-mentioned have been introduced into S. Africa in recent times. The group is characterised by the bracts of the female flowers being compressed, more or less rhomboid in outline or at least cuneate at the base and united to about the middle, persisting and thickening with the fruit which is usually about, or under, 5 mm. long. The flowers are in glomerules, those in the axils of the upper leaves consisting of male flowers with a few female flowers at the base and those of the lower leaves purely female. The plants are procumbent or decumbent to sub-erect, usually with many stems radiating from the tap root but in some specimens of *A. erosa* with a single erect stem.

It must be borne in mind that these species hybridise easily and since all but *A. erosa* are relished by stock they become widely spread and the introduced species, or their hybrid progeny, may be met with away from the areas where they were introduced. In this way it is difficult to tell whether a species is indigenous or not.

#### KEY.

Subtending leaves much reduced towards the apices of the branchlets giving the inflorescence a spike-like appearance; fruiting bracts very broadly sub-rhomboid in outline, usually tuberculate; leaves deeply incised with involute margins.....*A. erosa*.  
Subtending leaves not reduced towards the apex of the branchlets, inflorescence distinctly axillary; fruiting bracts never tuberculate:

Plants prostrate; leaves usually under 2 cm. long and 6 mm. broad; fruiting bracts distinctly rhomboid in outline with deltoid apical lobes, usually entire or with 2 small teeth near the base; fruit becoming semi-baccate when ripe and often turning red or orange; female flowers 1 to few in the axils of the lower leaves.....*A. semibaccata*.

Plants decumbent-erect or erect; fruit never becoming baccate when ripe but more or less bony; female flowers many in the axils of the lower leaves:

Leaves usually truncate at the apex; fruiting bracts with short, more or less rounded and toothed apical lobes; fruit not stipitate, indurating as a whole.....*A. muelleri*.

Leaves rounded at the apex; fruiting bracts with broadly deltoid apical lobes, toothed, the middle tooth the largest and deltoid; fruit with a stipe-like solid base which is the first to swell and indurate.....*A. suberecta*.

#### COMPOSITAE.

*Helichrysum coactum* M. D. Henderson sp. nov., affinis *H. umbraculigerum* Less, sed caulibus non ramosis tenuioribus, foliis angustis linearibus basi non attenuatis utrinque dense lanatis concoloribus et non fasciculatis differt.

*Herba* erecta, radicibus fibrosis. *Caules* 40–45 cm. alti non ramosi, graciles, dense albo-lanati, foliati. *Folia* linearia, 3–3.5 cm. longa, 3 mm. lata, basi non attenuata, utrinque dense albo-lanata, concolora. *Capitula* 3–4 mm. longa, homogama, 5-flora, cymis densissimis terminalibus planis usque ad 2 cm. diam. disposita. *Involucrum bracteae* nitido-flavae. *Receptaculum* planum. *Flores* hermaphroditi. *Achaenia* glandulosa; setae 1–2.

NATAL.—Bergville Div.: Cathedral Peak Forest Research Station Catchment 1, at 6,050 ft. Jan., Killick 1354.

NOTE.—Mr. B. de Winter reports that *Hutchinson* 4551 and 4593 in Kew Herbarium belong to this species.



Herbaceous plants. *Roots* numerous, fine, fibrous. *Stems* 40–45 cms. high, unbranched, slender, erect, several growing together, densely white-woolly especially at the apex, becoming glabrous at the base, leafy. *Leaves* linear, 3–3.5 cm. long, 3 mm. broad, very slightly or not narrowed to the base, amplexicaul, sometimes shortly decurrent; densely whitish-woolly on both surfaces concolorous; midrib conspicuous on undersurface. *Heads* 3–4 mm. long, homogamous, 5-flowered, terminal in very dense flat-topped cymes (up to 2 cms. across); peduncles felted together as in *H. umbraculigerum* Less. *Involucral bracts* bright yellow, few, in 3–4 rows, erect, oblong or more or less spatulate, truncate, longer than the florets. *Receptacle* smooth. *Florets* hermaphrodite, 1.5–2 mm. long; apex of corolla lobes with thickened margins. *Achenes* glandular; pappus of 1–2 caducous bristles.

These plants are to be found growing in vleis on the Drakensberg in Natal and are reported to match two specimens in Kew collected by Hutchinson. The heads are very similar to those of *H. umbraculigerum* Less but the leaves differ considerably, those of *H. umbraculigerum* being more or less ovate and much attenuate to the base, discolorous and sometimes fasciculate, while those of *H. coactum* are linear, not or but very slightly narrowed to the base, concolorous and never fasciculate.

***Helichrysum grandibracteatum* M. D. Henderson**, sp. nov., affinis *H. randio* S. Moore, sed planta tota caniore, capitulis dense corymbosis, pedunculis brevioribus, involucri bracteis acutioribus nitido-albis et floribus multo longioribus differt.

*Caules* erecti, 15–20 cm. alti, e rhizomate perenni lignes orti, basi dense foliati. *Folia* radicalia et inferiora caulina linearia, acuta, 6–7 cm. longa, 0.3 cm. lata, basi non attenuata, infra prominentia multi-nervosa; folia caulina superiora 2–4 cm. longa, lineari-lanceolata, acuta, sessilia; folia omnia infra albo-lanata, supra viridia (interdum purpurata) et glabra. *Inflorescentia* compacta terminalis corymbosa. *Capitula* late obconica, 1 cm. longa, 1.5–2 cm. lata, homogama, flores flavi. *Involucri bractee* nitido-albae, acutae; bractee interiores flores duplo longiores. *Achaenia* breviter hirsuta. *Pappi setae* numerosae, tenues, liberae, basi pilis patentibus intermixtae.

NATAL.—Bergville Div.: Cathedral Peak Forest Research Station 6,600 ft., Nov., Killick 1149 (Type); Mont-aux-Sources, Nov., Schweickerdt s.n., 8,000 ft., Oct., Sidey 2004.

CAPE.—Mt. Currie, Nov., Goossens 311; Victoria East, 5,500 ft., Nov.–Dec., Dyer 780.

NOTE.—Mr. B. de Winter reports that Baur 541 and McOwan 2091 in Kew Herbarium also belong to this species.

*Stems* 15–20 cm. long, sometimes shorter, many arising from a perennial, woody, sometimes divided, rootstock, white-woolly, striate, densely leafy at the base. *Leaves* white-woolly on undersurface, green and more or less glabrous on upper surface, many-nerved; nerves prominent on under surface; radical and lower cauline linear, acute, 6–7 cm. long, about 3 mm. broad not narrowed to base; upper cauline similar, 2–4 cm. long, linear-lanceolate, acute, sessile, not narrowed to the base, sometimes purplish on upper surface when dry. *Inflorescence* a compact few-headed terminal corymb. *Heads* shortly pedunculate, homogamous, many-flowered, broadly obconic, 1 cm. long, 1.5–2 cm. wide at the top when pressed. *Involucral bracts* shiny-white, glabrous, in many rows; outer shorter than inner, lanceolate, acute imbricate; inner almost twice as long as florets. *Receptacle* honeycombed with margins of pits shortly produced. *Florets* hermaphrodite and fertile. *Corolla* yellow, 5 mm. long; tube sub-cylindric, very slightly widened upwards, shortly 4–5-lobed. *Achenes* shortly hirsute, angled when young, becoming more or less cylindric when mature. *Pappus* of numerous fine bristles about as long as corolla; bristles free, but with intermingling patent hairs at the base, apex with looped hairs.

The earliest collection in the National Herbarium is that made by R. A. Dyer in 1926 on the main ridge towards The Hogsback in the Victoria East Division. The specimen was labelled "near *H. argentissimum*" from which species, however, it is quite distinct. Subsequent collections were matched with this specimen. The species occurs in grassveld at high altitudes in the mountains of Natal and eastern Cape. Although resembling *H. randii* S. Moore, this species is readily distinguished by the corymbose heads with long acute shiny-white involucre bracts and the more grey colour of the leaves and stems. *H. argentissimum* J. M. Wood has large solitary white heads and densely woolly-tomentose leaves.

***Helichrysum scopulosum* M. D. Henderson, sp. nov., affinis *H. fulgido* Willd., sed foliis basalibus dense rosulatis molliter et dense lanatis late obovatis differt.**

*Herba* 8–30 cm. alta. *Folia* basalia numerosa, rosulata, sessilia, obovata, obtusa, dense albo-lanata, 1–10 cm. longa, 1–4 cm. lata. *Pedunculi* erecti, graciles, e rosula orti, dense albo-lanati, foliis parvis 2–4 cm. longis et 0.5 cm. latis lanceolatis acutis sessilibus et lanatis interdum foliis inferioribus oblongis. *Capitula* heterogama, multiflora, floribus marginalibus femineis paucis. *Receptaculum* plusminusve planum, alveolatum. *Achaenia* glandulosa. *Pappi* setae paucae liberae.

NATAL.—Bergville Div.: Cathedral Peak Forest Research Stn., Catchment 2, 7,400 ft., Nov., Killick 1554 (Type); Cathedral Peak 8,000–9,000 ft., July, Esterhuysen 10228; 12864; Mont-aux-Sources, Hutchinson, Forbes & Verdoorn 66; Weenen Div.: MnWeni Drakensbergen 8,000–9,000 ft., July, Esterhuysen 14533; National Park Area, Drakensbergen 8,000 ft., July, Esterhuysen 15552, Saddle Rookeries Drakensbergen 8,000 ft., July, Esterhuysen s.n.; Ndedena area, Drakensbergen 8,000 ft., July, Esterhuysen 17346.

Herbaceous plants 10–40 cm. high. *Stem* erect, sparingly branched or simple, densely clothed with leaves at the base, slender above, densely white woolly with wide-spaced leaves. *Leaves* densely and softly, whitish-woolly on both surfaces at the base becoming thinly woolly or setose on the slender part of the stem; basal crowded on the stem to form a cushion-like rosette on the ground, sessile, obovate, obtuse, 1–10 cm. long, 1–4 cm. broad, venation inconspicuous; upper lanceolate, acute, 2–4 cm. long, 0.5 cm. broad, sessile not narrowed to the base. *Heads* large, 3–4 cm. broad, solitary, terminal, heterogamous with a few marginal female florets and numerous hermaphrodite florets. *Involucral bracts* bright yellow, radiating, glossy, lanceolate, acute, inner shorter than median, outermost foliaceous, woolly. *Receptacle* flat or slightly convex, honeycombed. *Style* sometimes with a globose swelling at the base within the corolla tube. *Achenes* glandular. *Pappus* bristles few, free.

This species has been collected only on the Drakensberg of Natal where it is common on steep rock faces with its roots in crevices. Specimens have remained unnamed in the National Herbarium for some time with the exception of the one collected by Hutchinson, Forbes & Verdoorn in 1930 which was at first called *H. fulgidum* Willd., which species the new one most closely resembles. It is, however, readily distinguishable by the soft wolliness and cushion-like habit of the lower rosette of leaves. The heads produced by *H. fulgidum* are usually smaller than those produced by *H. scopulosum*, but are otherwise very similar.

***Helichrysum tenax* M. D. Henderson sp. nov., affinis specibus Polylepidae, sed foliis inferioribus (30 cm. sub inflorescentia) multo majoribus et foliis superioribus oblongis non lanceolatis differt.**

*Planta* herbacea, basi semi-lignea, 90 cm. alta. *Folia* glanduloso-setosa, utrinque viscida, concolora; inferiora magna, 12–20 cm. longa et 4–8 cm. lata, obovata, sessilia, obtusa, superiora parva, 7 cm. longa et 2 cm. lata infra inflorescentiam ad usque 3 cm. longa, oblonga, sessilia, amplexicaulia. *Inflorescentia* terminalis corymbosa

vel paniculata, pendunculis albo-lanatis, capitula heterogama, discoidea, 1.5–2 cm. diam. *Involucri bracteae* nitido-flavae, splendidissimae. *Achaenia* glandulosa. *Pappi setae* paucae, caducae.

NATAL.—Bergville Div.: Cathedral Peak Forest Research Station, 5,800 ft., Dec., *Killick* 1632 (Type); Dec., *Codd & Dyer* 6249; Cathedral Peak, Nov., *Bayer*; Top of Mont-aux-Sources 11,000 ft., March, *Evans* 542. Estcourt Div.: Cathkin Peak Hostel 6–7,000 ft., *West* 26; Pasture Research Station 4,300 ft., Oct; *Acocks* 9847; Weenen Div.: Draycott Hill, 4,300 ft., June, *Acocks*; Currie Div.: Kokstad, Dec., *Phillips* 3493.

BASUTOLAND.—Maluti Mts.: 7–8,000 ft., *Staples* 86.

A herbaceous much branched plant with a semi-woody base, 90 cm. high. *Stem* more or less white woolly pubescent especially in the upper part, ribbed, with a pith in the centre. *Leaves* glandular-setose, viscid on both surfaces, concolorous; lower large, 12–20 cm. long, 4–8 cm. broad on the average, obovate, sessile, apex more or less obtuse, midrib and veins hairy beneath, internodes very short; at approximately 20–30 cm. below the apex leaves abruptly reduced in size from 7 cm. long, 2 cm. broad to less than 3 cm. long under inflorescence, oblong, broadly acute or obtuse, sessile, auriculate, sometimes very shortly decurrent, internodes longer, midrib sometimes slightly woolly at the base beneath. *Inflorescence* a terminal corymb or panicle with very woolly peduncles. *Heads* heterogamous, discoid, 1.5–2 cm. in diameter with one row filiform female florets surrounding very numerous hermaphrodite florets. *Involucral bracts* bright yellow, glossy, radiating, inner shorter than median, outer small, woolly on outside. *Receptacle* honeycombed, flat or slightly convex. *Corolla* of female florets inflated in lower half, upper half narrow cylindrical with spreading triangular lobes; of hermaphrodite florets broader than female corolla, slightly inflated in lower half, upper half gradually widened to the triangular lobes. *Anthers* with long acuminate basal tails, apex with a short obtuse appendage. *Style branches* truncate, glandular at the apex. *Achenes* obscurely angled, glandular. *Pappus* bristles few, caducous.

The first record of this species in the National Herbarium is a specimen collected by M. S. Evans in 1898 at the top of Mont-aux-Sources. It was originally identified as *H. setosum* Harv., which species, in the *Polylepidea* group, it most closely resembles. The new species is readily distinguishable from all members of the above group by the very large sticky leaves on the lower part of the stem and the oblong, not lanceolate, upper leaves. The plants are bushy, reported to be up to seven or more feet high and are common on hillsides in the mountainous regions of Natal, Basutoland and the eastern Cape. Glandular hairs on the leaves trap and hold fast small insects which alight on the surface, hence the specific name. The plants were thought to be insectivorous when the remains of the bodies of these insects were first noticed in 1945 but no further evidence has yet been produced.

*Helichrysum tenuifolium* Killick, sp. nov., affinis *H. trilineato* DC., sed habitu robustiore, foliis longioribus tenuioribus et acutioribus differt.

*Frutex* ligneus, 0.9–2 m. altus. *Rami* albo-lanati maxime apicibus. *Folia* patentia, sessilia, linearia, 0.7–1.8 cm. longa, 1–1.5 mm. lata, revoluta, 3-venata; apex acutus, recurvatus, mucronulatus. *Capitula* campanulata, 3.5–5 mm. longa, 3–4.5 mm. lata, apicibus ramorum sub-corymbosa. *Pedunculi* 1–5 mm. longi, albo-lanati. *Bracteae* involucri 5-seriatae, exteriores albae apicibus saepe rubicundae, intimae flavae. *Receptaculum* leviter convexum, fimbriatum. *Flores* 20–30, flavi; marginales ♀ filiformes; interiores ♂ tubulosi, limbo ampliato. *Achaenia* breviter pubescentia.

NATAL.—Bergville District: on the banks of the Mlambonjwa River, Cathedral Peak Area, *Schelte* 960; on the boulder-bed of the Inhlwasine River, Cathedral Peak Forest Influences Research Station, *Killick* 1438, 1591 (type).



A robust, woody shrub, 0.9–2 m. high. *Branches* white-woolly especially at the ends, older portions rough with persistent leaf bases. *Leaves* patent, sessile, linear, 0.7–1.8 cm. long, 1–1.5 mm. broad, revolute; apex acute, recurved, mucronulate; upper surface with 3 parallel veins, glabrous to sparsely hairy, lower white-woolly. *Capitula* campanulate, 3.5–5 mm. long, 3–4.5 mm. broad, arranged in dense sub-corymbose terminal cymes. *Peduncles* 1–5 mm. long, white-woolly. *Involucral* bracts 5-seriate; the innermost linear-spathulate, reflexed at the tips, yellow, glabrous; the outer successively shorter, lanceolate, white-woolly, often salmon-pink at the tips. *Receptacle* slightly convex, fimbriate. *Florets* 20–30, yellow; marginal ♀ filiform inner  $\frac{3}{4}$  tubular, widening above. *Achenes* minutely pubescent.

*H. tenuifolium* is a robust shrub, 3–6½ ft. high with darkish-green, linear leaves and showy sub-corymbose cymes of yellow heads. It flowers from November to February. Closely related to *H. trilineatum* DC., it differs in its taller habit and in the longer, narrower and acuter leaves.

**Senecio brevidentatus** *M. D. Henderson*, sp. nov., affinis; *S. tugelensi* Wood & Evans, sed inflorescentia paniculata, caulibus basi pilosis, marginibus foliorum breviter dentatis non tenuiter serratis differt.

*Herba* erecta, 25 cm. alta; rhizoma fibrosum. *Caules* basi parce pilosi. *Folia* radicalia oblanceolata, obtusa, 6–7 cm. longa, 1–1.5 cm. lata, attenuata, marginibus breviter dentatis; folia inferiora caulina oblonga, obtusa vel plusminusve acuta, 2–5 cm. longa, 0.5–1 cm. lata, sessilia, auriculata, marginibus breviter dentatis et ciliatis; folia suprema parva, lanceolata, ad 2 cm. longa, acuta auriculata, marginibus integris ciliatis. *Inflorescentia* paniculata; capitula radiata, flava ample calyculata; involucri bracteae spice nigrae. *Achaenia* juvenes leviter pilosa.

NATAL.—Bergville Div.: Cathedral Peak Forest Research Station in vlei in Catchment 1, 6,050 ft., Nov., Killick 1152 (Type). Note: Mr. De Winter at Kew reports that Wood 1010, 391, 162 in Kew Herbarium belong to this species.

*Herb* about 25 cms. high, erect, simple or branching above the base; rootstock fibrous; roots robust; *Stems* striate, sparsely covered with white hairs at the base, becoming glabrous. *Leaves* glabrous or with ciliate margins; radical oblanceolate, obtuse 6–7 cm. long, 1–1.5 cm. broad, narrowed to the base; margins shallowly dentate; lower cauline oblong, obtuse or more or less acute, sessile, 2–5 cm. long 0.5–1 cm. broad auricled at the base but not stem clasping, margins shallowly dentate, ciliate; upper cauline reduced in size, lanceolate, acute, auricled at the base 2 cm. long, margins entire, ciliate. *Inflorescence* a lax panicle; peduncles elongate bearing minute lanceolate bracts. *Heads* 1 cm. long, radiate. *Involucre* of about 20 linear, glabrous involucral bracts with minute black tips, calyced, with 8–9 linear basal bracts. *Ray florets* 10–12 mm. long, limb longer than tube. *Disc florets* numerous, apices of lobes more or less obtuse with a minute glandular cushion on the outside. *Anthers* with a short obtuse apical appendage. *Achenes* slightly hairy when young. *Pappus* of numerous fine barbellate bristles.

Although there is only one collection of this species in the National Herbarium it is reported to match three unnamed specimens in Kew collected by Wood, probably also from Natal. It was reported to be fairly common in a vlei on the Drakensberg in Natal. The species most closely resembling *S. brevidentatus* is *S. tugelensis* Wood & Evans which also occurs at high altitudes in Natal, but the two are easily distinguishable by the several headed paniculate inflorescence, the hairiness of the basal part of the stem and the shallowly dentate, sometimes ciliate, margins of the leaves of the new species, opposed to the one or two headed inflorescence, glabrous stem and glabrous serrate margins of the leaves of *S. tugelensis*.

**Senecio macroalatus** *M. D. Henderson*, sp. nov., affinis *S. decurrenti* DC. et *S. digitatifolii* DC., sed planta omnino glabra, foliis multo profundioribus et acutioribus serratis, capitulis inconspicue calyculatis, involucri bracteis apicibus nigris differt.

*Herba* erecta, usque ad 67 cm. alta, glabra. *Folia* irregulariter et profunde serrata, apicibus longis acutis; folia radicalia 25 cm. longa, petiolis longis; folia inferiora caulina 17 cm. longa et 3.5 cm. lata, valde decurrentia, alis profunde serratis usque ad 1 cm. latis; folia suprema parva, lanceolata, basi auriculis incis. *Inflorescentia* paniculata. *Capitula* radiata, flava, inconspicue calyculata. *Involucri bractee*, 7–8 mm. longae, apice nigrae. *Achaenia* glabra, 10-costata, 2 mm. longa.

**NATAL.**—Bergville: Cathedral Peak Forest Research Station, 9,800 ft., in Organ Pipes' Pass, March, Killick 1486.

*Herb* up to 67 cm. high, glabrous. *Stem* erect, striate leafy, especially at the base. *Leaves* deeply and irregularly serrate on margin, apex long acute, midrib and reticulate venation prominent on undersurface; radical oblanceolate, 25 cm. long, 3 cm. broad, narrowed to a winged, clasping petiole; cauline oblong-lanceolate, 17 cm. long, 3.5 cm. broad, strongly decurrent in deeply serrate stem-wings, up to 1 cm. wide; uppermost small lanceolate with incised basal auricles clasping the stem. *Inflorescence* a dense terminal panicle, with small subulate bracts on the peduncles. *Heads* radiate, ray- and disc-florets yellow. *Involucre* cylindrical to campanulate, 7–8 mm. long; bracts 12, linear-lanceolate, more or less obtuse, with minute black bristly tips and narrow membranous margins; basal bracts few, a third the length of involucre bracts, with black or reddish tips. *Receptacle* honeycombed, margins of pits usually produced on one side only. *Corolla* of ray-florets 16 mm. long, limb 2–3 times as long as tube; of disc-florets 8 mm. long, lobes 1.5 mm. long, thickened and glandular. *Filaments* thickened below anthers. *Achenes* glabrous, 2 mm. long, 10-ribbed. *Pappus* of all florets of fine copious barbellate bristles.

Although common in the Koeleria-Festuca-Danthonia grassveld of Organ Pipes' Pass in the Drakensberg this species has not previously been collected for the National Herbarium and is not matched in the Kew Herbarium. The glabrous nature of the whole plant and the inconspicuously calyced heads with black-tipped involucre bracts very readily distinguish it from both *S. decurrens* DC. and *S. digitatifolius* DC., which like *S. macroalatus* have broadly decurrent leaves.

## CYCADACEAE.

**Encephalartos eximius** *Verdoorn* sp. nov., affinis *E. ghellinckii* Lem. sed plantis minoribus valde soboliferis 1- (rariter 2-) strobiliferis foliolis leviter latoribus differt.

*Planta* humilis valde sobolifera; truncus 25–60 cm. longus, circiter 25 cm. diam. *Folia* c. 65 cm. longa, sub-erecta; petiolus c. 10–20 cm. longus, 6 mm. diam., priori lanuginosus; pulvinus 3–4 cm. longus 2.5–3 cm. latus dense lanuginosus; rachis lanuginosa et nonnunquam villosa, glabrescens; foliola angusto-linearia, usque 9–13 cm. longa, 4–5 mm. lata, ad basin et apicem rachis minora, patentia, apicibus pungentibus, marginibus revolutis, infra prominente 5-nervata; nervi pilosi. *Strobilus masculinus* 1-natus (vel rariter strobili 2-nati), plus minusve cylindricus apicem et basin versus leviter attenuatus, 13–22 cm. longus, 4.5–7 cm. diam., dense lanuginoso-tomentosus; pedunculus 3–11 cm. longus; bractee longae angustae dorso dense tomentosae; squamae c. 2 cm. longae, 1.8 cm. latae, subtus numerosis micro-sporangiis obtectae; facies dense tomentosa, sub-orbicularis vel sub-rhomboidea, c. 1.2 cm. × 5–8 mm. × 1–2 mm.; sub tomentum leviter concava. *Strobilus femineus* 1-natus, dense tomentosus, 20–30 cm. longus, 16–18 cm. diam.; pedunculus c. 3.5 cm. longus, basin 2–3 cm. diam., versus apicem 4 cm. diam., bractee multae, angustae, 2–5 cm. longae, 3–8 mm.

latae, dorso dense tomentosae; squamae c. 3 cm. longae 4 cm. latae, facies plana (sub tomentum leviter concava), plus minusve rhomboidea 4 cm.  $\times$  2.5 cm.  $\times$  1.3 cm. *Semina* citrina pallide salmonea suffusa deinde succineo-brunea.

CAPE PROVINCE.—Bedford Div.: Eildon, *Dyer* 5331. *Story* 4017; 4019 (male cone); 4021 (type, female); Huntly Glen, *Dyer* 5333; *Story* 4014; 4022; 4023; Daggaboersnek, *Story* 4018. Cradock Div.: Cradock Mts. towards Tarkastad, *Marloth* 2151. (Cult in Kirstenbosch Gardens, origin unknown, *Henderson* 1566).

#### PLATES 2, 3 and 4.

Plants dwarf, suckering freely at the base, stems above ground level usually 25–60 cm. long and about 25 cm. diam., leaf-scars variable, the average diagonal measurements  $3 \times 1.5$  cm.; remains of bracts grey, smooth, indurated, about 3 cm. long and 2.5 cm. broad at the base. *Leaves* about 65 cm. long, more or less erect, sometimes rather spirally twisted; petiole 10–20 cm. long, bluntly three-angled, woolly pubescent in parts when young, sometimes with long straight hairs as well, about 6 mm. diam., widening slightly towards the base where it is about 9 mm. broad just above the pulvinus; pulvinus about 3–4 cm. long, and 2.5–3 cm. broad in the middle, densely lanuginose; rhachis woolly pubescent in parts with curly and sometimes straight grey hairs, becoming glabrous, rounded below and flatly rounded above, sometimes with a rather faint ridge down both surfaces; leaflets narrowly linear, the median about 9–13 cm. long, 4–5 cm. broad, reducing gradually in size towards base and apex of rhachis, entire with revolute margins and 5 prominent, sparsely pilose nerves on the lower surface, pungent at the tip, narrowing very slightly at base before widening into the foot-like connective to the rhachis, spreading or forming a wide V, not overlapping. *Male cones* 1- or rarely 2-nate, more or less cylindrical, tapering slightly to base and apex or rounded at the apex, 13–22 cm. long, 4.5–7 cm. diam. with scales in about 17 oblique rows; peduncle 3–11 cm. long with long, narrow, dorsally tomentose bracts; median scales removed from the cone about 2 cm. long, 1.8 cm. broad, the lower surface completely covered by numerous microsporangia; scale faces densely felted with tawny tomentum, appearing sub-circular to sub-rhomboid in outline, varying in size, about 1–2 cm. by 5–8 mm. and only 1–2 mm. thick (when tomentum is removed), flattish, with a central depression, hidden by the tomentum. *Female cones* solitary (in all specimens seen), densely lanuginose with tawny or off-white tomentum, 20–30 cm. long, 16–18 cm. diam., scales in about 9 oblique rows, peduncle about 3.5 cm. long, 2.5 cm. diam. at base, up to 4 cm. diam. at top; bracts many, narrow, 2–5 cm. long, 3–8 mm. broad, dorsally densely tawny tomentose; median scale removed from the cone, 3 cm. long (from base of stipe to exposed surface) and 4 cm. broad at greatest width; stipe and sinus arms yellowish; scale faces more or less flat (not prominent), with a shallow concave rhomboid umbilicus hidden by tomentum, sub-rhomboid in shape, diagonal measurements up to 4 cm. by 2.5 cm. and about 1.3 cm. thick. *Seed* pale orange-yellow through salmon suffused orange to amberbrown.

In the article "Materials for a Revision of the South African Species of *Encephalartos*", Journ. of S.A. Bot. Jan. 1945, page 62, M. R. Henderson described a plant growing in Kirstenbosch Gardens of which the place of origin was unknown. All efforts by interested botanists to find the species in the veld failed until 1951. In April of that year Dr. R. Story, Botanical Survey Officer, stationed at Grahamstown located a group of cycads in the mountains N.E. of Bedford. They were growing in very little soil on dolerite and seemed in poor condition. Being unable to match it with any species in the Albany Museum and suspecting it to be an undescribed species Dr. Story sent material to the National Herbarium, Pretoria, where it was recognised as being the same species as the Kirstenbosch plant mentioned above.

It was found to be closely related to *E. ghellinckii* Lem. of the Drakensberg and in some respects like *E. cycadifolius* Lehm. which occurs on koppies in the grassveld of Queenstown District. It is similar to these species in that the leaflets are narrow



and entire, the cones densely and thickly felted tomentose and the seeds yellow-orange to brown, never scarlet. It differs in being smaller than both these species, suckering more freely at the base, and in the cones being borne singly and only rarely with 2 male cones on a plant. Besides these 3 differences it may be distinguished from the nearer neighbour, *E. cycadifolius*, in that the leaflets are narrower and more spreading, that is the pairs are not arranged V-wise along the axis like those of *E. cycadifolius*.

In comparison with *E. ghellinckii*, which occurs on the eastern slopes of the Drakensberg range and as far south as near Flagstaff in the Cape Province, the leaflets of *E. eximius* are slightly broader. They do not have the margins as strongly inrolled as *E. ghellinckii* and the prominent nerves of the undersurface are therefore obvious. In our species too, these nerves are sparsely pubescent with long curly hairs. The pubescence in general on these two species is rather similar but on the whole *E. ghellinckii* is more generally woolly-villous, having curly and straight hairs. Straight hairs are, however, sometimes found on the new species.

From existing revisions on the genus one might be led to assume that the early travellers and botanists overlooked this species completely. But since this seemed doubtful old records and likely descriptions and specimens were combed for possible clues. One definite find was a specimen in the Marloth Herbarium, Marloth 2151, collected in the "Cradock Mts. towards Tarkastad altitude 1200 m., Oct. 1895" which was obviously the same as our species. It had been confused with *E. Friderici-Guilielmi*, that is *E. cycadifolius* Lehm. Another case of possible confusion of our species is the record of *E. lehmannii*, the Karoo cycad, from Bedford (see Fl. Cap. Vol. 5, sect. 2, page 36). In all probability this is our species but since the record is not supported by a specimen among the citations proof of this is lacking.

#### ERICACEAE.

***Erica gazensis* H. Wild sp. nov., *E. lanceoliferae* S. Moore affinis, pilis glandulosis distinguenda; ab *E. milanijana* Bolus antheris appendiculatis differt.**

*Suffrutex* ad 60 cm. altus, adscendens vel erectus, pilis eglandulosis brevibus et glandulis stipitatis longioribus paucioribusque indutus. *Ramuli* numerosi, recti vel flexuosi, rubro-brunnei, diametro circa 1 mm., teretes; internodiis 2-7 mm. longis. *Folia* quaterna; petiolus 0.2 mm. longus, complanatus, breviter pubescens; lamina oblongo-lanceolata, subacuta, revoluta, griseo-viridis, minima 2.6 mm. longa, 0.8 mm. lata, maxima 4 mm. longa, 1.5 mm. lata, supra minute muricata, pilis brevibus eglandulosis et principue ad marginem pilis longis glandulosis sparsim vestita, subtus pallidior, dense eglanduloso-puberula, pilis glandulosis breviter stipitatis admixtis, nervo mediano prominente. *Inflorescentia* ad ramulorum ultimorum apices in umbellas subglobosas disposita. *Flores* quaque umbellae 8-12; pedicelli tenues, 2-4 mm. longi; bractea 1, aliquando deessens, pedicelli dimidio superior vel inferior, oblongo-linearis, breviter eglanduloso-pilosa et margine stipitato-glandulosa, 0.2 mm.-0.8 mm. longa, 0.15 mm.-0.8 mm. lata; bracteolae 2, saepe deessentes, prope calycem, oppositae vel sub-oppositae, bractee similes sed minores, ca. 0.2 mm. longae; calyx quadripartitus, segmentis lanceolatis vel ovato-lanceolatis, 1 mm. longis, basi 0.6 mm. latis, uninervatis, membranaceis, pilis brevibus eglandulosis et glandulis marginalibus longistipitatis vestitis; corolla roseo-punicea, campanulata vel paulo urceolato-campanulata, glabra vel sparsim pilis minutis eglandulosis marginata, 1.7-2.1 mm. longa, 1.7-2.1 mm. lata, lobis 4 apice rotundatis, erectis vel leviter recurvis, 0.75 mm. longis; stamina 7-8, inter disci lobos emergentes, filamentis complanatis, 1.2 mm. longis, antheris breviter exsertis, oblongis, 0.75-0.9 mm. longis, purpureo-fuscis, scabridis, bi-appendiculatis, appendiculis supra basin dorsifixis, deflexis, lamelliformibus, basi latis, 0.35-0.5 mm. longis, secundum marginem paulo scabrido-pubescentibus; ovarium depresso-globosum, villosum, eglandulosum, altitudine 0.38-0.8 mm. diametro 0.42-1.2 mm.; discus 7-8-lobatus; stylus tetragonus, glaber, 2.4 mm. longus, 1 mm. exsertus, apice subcapitatus.

S. RHODESIA: Melsetter: Chimanimani, 2,200 m., along open streams, July, *Thompson* 16 (type in S.R.G.H., Salisbury); Greenmount, 2,000 m., Bracken grassland, Sept., *Crook* 127 (S.R.G.H. 31413); Albany, 1,800 m., in *Brachystegia spiciformis* woodland, July, *Crook* 11 (S.R.G.H. 29010); Rocklands, 1,500 m., Oct., *Chase* 2976 (S.R.G.H. 31197); Chimanimani Mts., 2,000 m., June, *Munch* 203 (S.R.G.H. 24452).

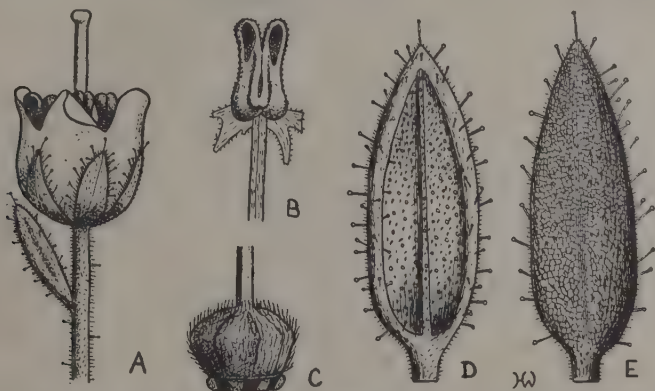


FIG. 4.—*Erica gazensis* H. Wild. A—Flower,  $\times 8$ ; B—Anther,  $\times 17$ ; C—Ovary and disc,  $\times 26$ ; D—Leaf, abaxial surface,  $\times 17$ ; E—Leaf, adaxial surface,  $\times 17$ .

The relationships of *E. gazensis* can be readily seen if it is inserted in the key given by Alm & Fries in their monograph "Die tropischen Arten der Gattung *Erica* L." Ark. Bot. Band 2A, No. 7 (1927). The revised portion of this key would then be as follows:—

Branches and leaves glandular:

    Anthers muticous..... *E. milanjiana*.

    Anthers appendaged..... *E. gazensis*.

Branches and leaves eglandular..... *E. lanceolifera*.

*E. gazensis* is rather a variable species and the variations seem haphazardly distributed among the available material; however, the structure of the floral parts is comparatively uniform. *Chase* 2976 has its umbels noticeably crowded together; *Crook* 127 a continuous minute pubescence along the margins of the corolla lobes whilst the type has merely a very few minute hairs on a very small proportion of the corolla lobes and the remainder have completely glabrous corollas. *Crook* 127 and 11 both differ from the rest in having less revolute leaf margins. This last difference could be due to differing conditions of humidity and shade. The specific name is derived from the name of that part of S. Rhodesia and Portuguese East Africa which extends on both sides of the border to include the Melsetter, Chipinga, Chimanimani areas and Southern Manica province. It is defined by Swynnerton in J. Linn. Soc. Bot. XL, p. 2 (1911).

*Erica eylesii* Bolus var. *blaerioides* H. Wild, var. nov., staminium numero vulgo 4, rarius 5, nunquam usque 8, a typo distinguitur.

PORTUGUESE EAST AFRICA.—Manica; Chimanimani Mts., 2,000 m., June, *Munch* 206 (type of var. in S.R.G.H., Salisbury); Chimanimani Mts., 1,700 m., on rocky outcrops at streamside July, *Pedro & Pedro* 7331; Chimanimani Mts., 1,700 m.,

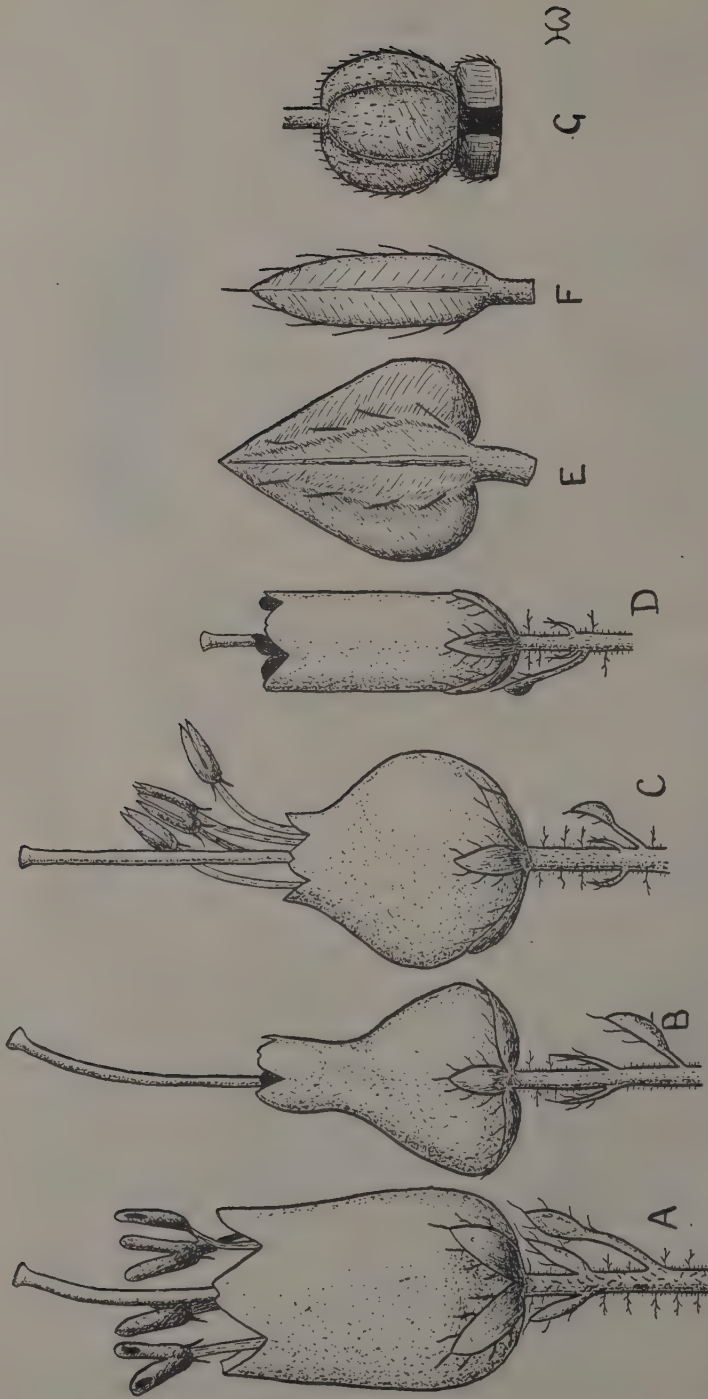


FIG. 5.—*Erica eylesii* Bolus var. *blaerioides* H. Wild. A, B, C—Flower forms,  $\times 12$ ; D—Bud, just opened,  $\times 12$ ; E—Unfolded leaf,  $\times 12$ ; F—Folded leaf,  $\times 12$ ; G—Ovary and disc,  $\times 24$ .



margin of R. Mevumosi, in ericoid scrub, July, *Pedro & Pedrogao* 7318; Chimanimani Mts., 1,700 m., on rocky outcrops, by streamside, July, *Pedro & Pedrogao* 7332; Chimanimani Mts., 1,500 m., by stream, June, *Wild* 2903.

S. RHODESIA—Melsetter; Chimanimani Mts., 2,000 m., near stream, June, *Wild* 2937; Melsetter town lands, 1500 m., July, *Crook* 4; Melsetter town lands, 1,500 m., very locally common, July, *Crook* 6; Chimanimani Mts., Bonde R., 1,500 m., June, *Wild* 2854; Chimanimani Mts., Musapa Gap, 1,000 m., Oct., *Munch* 338; Melsetter, 1,500 m., riverine, Aug., *Crook* 105.

In the last few years a good deal of material has been collected in the Chimanimani area which bears the closest resemblance to *Erica eylesii* Bolus but has flowers with only four stamens and sometimes much broader ovate leaves. The possibility was examined that this represented an undescribed *Blaeria* sp. with a superficial resemblance to *E. eylesii* but, apart from the stamen number and variation in leaf shape, no other character could be found to distinguish it from *E. eylesii*. Although the undetermined specimens and *E. eylesii* fell fairly readily into two groups with either 4 or 8 stamens, odd flowers were found with 5, 6 or 7. Flowers with 5 stamens were fairly common on predominantly 4-anthered gatherings while 7-anthered flowers were fairly common in 8-anthered gatherings and only a very few flowers with 6 stamens were discovered, mainly on predominantly 8-anthered specimens.

It was concluded therefore, that the 4-anthered specimens constituted merely a variety of *E. eylesii*. This is of some significance since the only reliable character distinguishing the genus *Blaeria* L. from *Erica* L. is the possession of 4 stamens as against 8 (or rarely 6). It is fairly evident that this is a rather artificial distinction and the existence of an *Erica* sp. which can have from 4-8 anthers emphasises this more strongly. It would seem that the genus *Blaeria* can only be retained on the grounds of convenience. This otherwise rather poor reason does have some force, however, in practice, when the large size of the genus *Erica* is taken into consideration.

In the course of these investigations it was found that the leaves are often ovate and revolute at the margins only. On the same plant, however, linear-oblong or acicular leaves are often present and on examination prove to be derived by the folding of the cordate leaf along two adaxial ridges more or less parallel with the midrib. In many specimens one or other kind of leaf predominates and this at first sight suggests the presence of two species.

It is in the flower structure, however, that polymorphism is most apparent. Bolus has described the corollas of the type as being cyathiform and slightly constricted at the throat, Alm & Fries [who redescribed this species by mistake some three years later and, by a strange coincidence, gave it the same specific name—*Arkiv Bot.*, Stockholm, 21A, No. 7, 6 (1927)], in describing corollas from the same gathering, define them as inflated tubular to subovoid. An urceolate-globose form is perhaps the commonest on a wide range of gatherings but quite commonly a gathering will only shew tubular flowers with parallel sides. The buds are narrowly tubular or have a constriction in the middle of the tube. In addition, a small proportion of the flowers are very broadly pyriform with a narrow cylindric neck. In this case the anthers, although fertile, never become exserted and this may render self-pollination more likely. In all cases fertile capsules are produced. That these differences are of no taxonomic significance is proved by the fact that they are all represented on one branch on the type sheet of the variety. The accompanying illustration shews three flower forms, a bud, two leaf forms and the ovary, all drawn from the type sheet of the variety.

It should be noted further that the anther appendages of this species are sometimes much reduced and difficult to see. In this form it approaches closely *E. thryptomenoides* S. Moore, which appears to differ from *E. eylesii* only in its muticous anthers. The relationship of the two species requires further investigation with a wider range of material.

The author wishes to acknowledge with thanks the assistance of Miss I. C. Verdoorn of the National Herbarium, Pretoria and of Mr. N. S. Pillans and Miss Esterhuysen of the Bolus Herbarium who have seen the majority of the material used in drawing up this account.

### GERANIACEAE.

**Pelargonium jacobii** R. A. Dyer sp. nov., affinis *P. carnosum* L. foliis obovatis vel oblanceolatis dentatis facile distinguitur.

*Planta* suffrutescens succulenta, sparse ramosa, basi 2–4 cm. crassa, usque 40 cm. longa. *Folia* oblanceolata vel obovata, 4–9 cm. longa basin versus attenuata, pilosa, margine dentato vel leviter lobato. *Pedunculus* 5–20 cm. longus plus minusve ramosus, breviter pubescens ramis 3–7-floribus; bractee lanceolatae vel oblongo-lanceolatae, 5–7 mm. longae, 2.5–3.5 mm. latae. *Flores* pedunculati, pedicellis gracilibus 2–3 cm. longis glabris calycis calcaribus usque 2 mm. longo eis adnatis. *Sepala* oblonga, 8 mm. longa, 2.5–3.5 mm. lata, obtusa. *Petala* subaequalia, oblanceolata, spathulata, 9 mm. longa, apicem versus 3 mm. lata. *Ovarium* dense villosum; fructus 4.5 cm. longus, rostro pilis patulis albidis hirsuto.

CAPE PROVINCE.—Richtersveld; Kubus, August, Marloth 12345 (type); Arris Drift, Marloth 12345 b.

SOUTH WEST AFRICA.—Sandy flats east of Buchuberg, July, Dinter 6437.

#### PLATE 5.

*Plant* up to about 20 cm. tall and up to 40 cm. with inflorescence. *Stem* succulent, 2–4 cm. thick near base, sparsely branched, pubescent near tips of branches. *Leaves* obovate to oblanceolate, 4–9 cm. in total length, tapering into a petiole-like lower half and a swollen base, pilose; margin dentate or moderately lobed. *Peduncles* slender or stout, 5–20 cm. long, simple or up to 3-branched, minutely pubescent. *Bracts* subtending the pedicels more or less lanceolate or oblong-lanceolate, 5–7 mm. long, 2.5–3.5 mm. broad. *Flowers* white, pedicellate; pedicels slender, 2–3 cm. long, with the fused nectariferous calyx spur extending 2 mm. down, glabrous. *Sepals* oblong, 8 mm. long, 2.5–3.5 mm. broad, obtuse, glabrous or with a few hairs and becoming glabrous. *Petals* oblanceolate-spathulate, more or less equal, 9 mm. long and 3 mm. broad towards the apex. *Ovary* densely hairy; the beak elongating in the fruiting stage up to about 4 cm. long; seeds hirsute.

This species is closely related to *P. carnosum* L. from which it is readily distinguished by the entire leaves. It may be even more closely allied to *P. mirabile* Dinter, of which no authentically named specimen has been seen. Miss Esterhuysen of the Bolus Herbarium states that according to specimens in that Herbarium, the calyx of *P. mirabile* is very hairy and quite distinct from that of the present species.

The naming of this plant as *P. jacobii*, in honour of Colonel Robert Jacob Gordon of the Old Dutch East India Company, is resorted to because the surname has already been used. Gordon did much to assist botanical exploration prior to 1800, and must surely have been the first person to paint this species, so that it is desired to commemorate him in this way. A measure of appreciation of Gordon's work was expressed by the writer in an address to the South African Biological Society, which was published in the society's Pamphlet No. 14, 1949. The writings of V. S. Forbes in *Afrikaner Notes and News* (Afrikana Aantekeninge en Nuus), June, 1952, and elsewhere, should also be consulted if one wished to get a broad view of Gordon's remarkable personality.

The accompanying reproduction was made from a photograph of the original coloured illustration by Gordon which is in the Rijks Museum, Amsterdam. There is a copy of this painting in an album of "Paterson's Drawings" in the library of Sir Ernest Oppenheimer, Johannesburg.

## GESNERIACEAE.

***Streptocarpus kentaniensis*** Britten and Story, sp. nov., *S. meyeri* Burt et *S. luteae* C.B. Cl. affinis, a *S. meyeri* tubulo breviori differens, et quod tubulus fundo faucium maculatus est, a *S. lutea* quod flores violacei sunt, nec candidi nec lutei, ab ambabus limbo floris obliquo et foliis angustis fere linearibus.

*Herba* acaulis, rosulata, multifoliata; foliis crassulis, angustis, rigidis, ascendentibus, distincte petiolatis, inflorescentias multas ferentibus. *Folium* plerumque 10 cm. longum, 1.8 cm. latum, rugosum, acuminatum, villis brevibus non glanduliferis utrinque contactum, margine leviter crenato et leviter revoluta, nervis infra plurimis prominentibus, villis appressis; petiolus usque ad 3 cm. longus, rubens, pedunculis serie 3-4 in extremo emergentibus. *Pedunculus* 9-12 cm. longus, villis plerumque non glanduliferis, infra fuscus, deinde paullatim viridis, floribus 2, rariter usque ad 5. *Bractea* circiter 1 mm. longa, villis plerumque non glanduliferis. *Pedicellus* 1-2 cm. longus, villis plerumque glanduliferis. *Flos* plerumque 2.5-2.9 cm. longus. *Calyx* circiter 3 mm. longus, ad basin partitus segmentis angustis villis glanduliferis et eglanduliferis connectis. *Corolla* similiter pubescens; tubulus sub-violaceus, intus pulla viola diverse maculosus, cylindratus, plus minusve curvatus, faucibus ad circiter 6 mm. dilatatus, intus villosus, villis fundo longis, alibi brevioribus, ruga in longitudinem per medium fundum; limbus 1.7-2 cm. latus; lobus anticus et lobi ex utroque latere 6 mm., lobi aversi 5 mm., omnes apice orbiculati. *Stamina* filamentis tortis, purpureis, violaceis vel candidis, 4 mm., antheris circiter ad dimidiam partem tubuli allatis; staminodia duo, 1.5 mm. longa. *Pistillum* 1.3 cm. longum; stigma ultra antheras emens, ovarium stylusque dense villis longis glanduliferis et eglanduliferis connecti; ovarium viride, purpura reticulatum; stylus ovario aequilongus; stigma capitatum, ovatum; orbis annularis, colore croceus. *Capsula* gracilis, circiter 5 cm. longa, scabra; semina circiter 0.5 mm. longa et dimidio angustiora, ferme ovata, utroque fine rostrata, fusca, inaequaliter angulata et rugosa.

CAPE PROVINCE.—Kentani or Komgha district: on rocks in woods near Kei Mouth, July, *Flanagan* 2337; Kentani district: *Britten*, unnumbered; 2 miles S.E. of Kentani, mossy rock in rather dry forest, rare, 1,000 ft., August, *Story* 4038 in Albany Museum Herbarium (type).

A stemless herb with thick, stiff, narrow leaves, ascending, distinctly petiolate, bearing many inflorescences. *Leaf* usually 10 cm. long, but varying from 3 to 20 cm., usually about 1.8 cm. wide, rugose, covered with non-glandular short hairs on both sides, apex acute, margin slightly crenate and slightly revolute, upper side dark green, lower side pale, sometimes reddish; midrib very prominent below, with hairs appressed, other smaller veins numerous and also prominent, projecting to give the lower side a honeycombed appearance with the green tissue scarcely visible; petiole up to 3 cm. long, reddish, with peduncles arising in series of three or four at its distal end. *Peduncle* 9-12 cm. long, with hairs mostly non-glandular, brownish at base merging into green at top, usually two-flowered, but sometimes bearing as many as five flowers. *Bract* about 1 mm. long, with hairs mostly non-glandular. *Pedicel* 1-2 cm. long, with hairs mostly glandular. *Flower* 2.5-2.9 cm. long, smaller if growing under dry conditions. *Calyx* about 3 mm., cut to base, segments narrow, covered with hairs on outside, many glandular. *Corolla* similarly hairy, tube light lobelia violet, spotted variously with aconite violet inside, cylindrical, slightly curved, widening towards the throat where it is about 6 mm. wide, with hairs inside long on the floor, shorter elsewhere, and with a fold running down the centre of the floor; limb 1.7-2 cm. across; front lobe and side lobes 6 mm., back lobes 5 mm., all rounded at the apex. *Stamens* with characteristic twisted filaments, purple, lilac or white, 4 mm., bringing the anthers about half-way up the tube, anthers connivent, explosive, cells confluent, with powdery pollen oval-shaped when dry, round in water; staminodes two, 1.5 mm. long.



*Gynoecium* 1·3 cm. long; stigma protruding beyond the anthers; ovary and style densely covered with long hairs, many of them glandular; ovary green veined with purple; style white, nearly as long as ovary; stigma capitate, oval; disc annular, xanthine orange. *Capsule* slender, about 5 cm. long, scabrous; seeds a little over 0·5 mm. long and half as broad, roughly oval, beaked at each end, dark brown, irregularly angled and rugose.

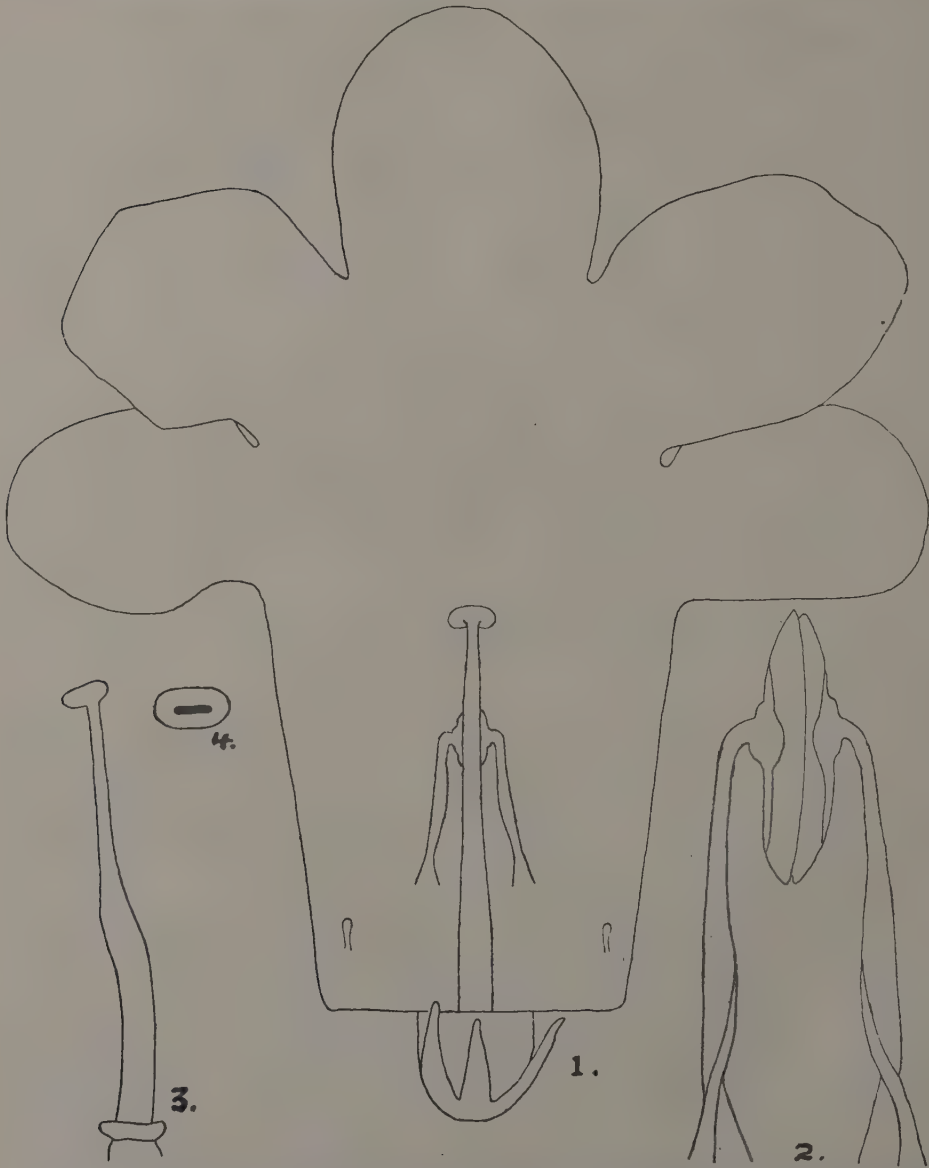


FIG. 6.—*Streptocarpus kentaniensis*: 1, flower opened out,  $\times 5$ ; 2, androecium,  $\times 12$ ; 3, gynoecium,  $\times 5$ ; 4, stigmatic surface,  $\times 10$ .

The following notes are by the second author, R. Story.

Plants of this species, grown by Mrs. Turnbull near Kentani, were sent by Mr. S. Stent in July and November, 1940 to Miss L. L. Britten in Grahamstown. Mrs. Turnbull sent more in 1943. They had been found growing in a "rather dry place", and were kept moderately watered in cultivation.

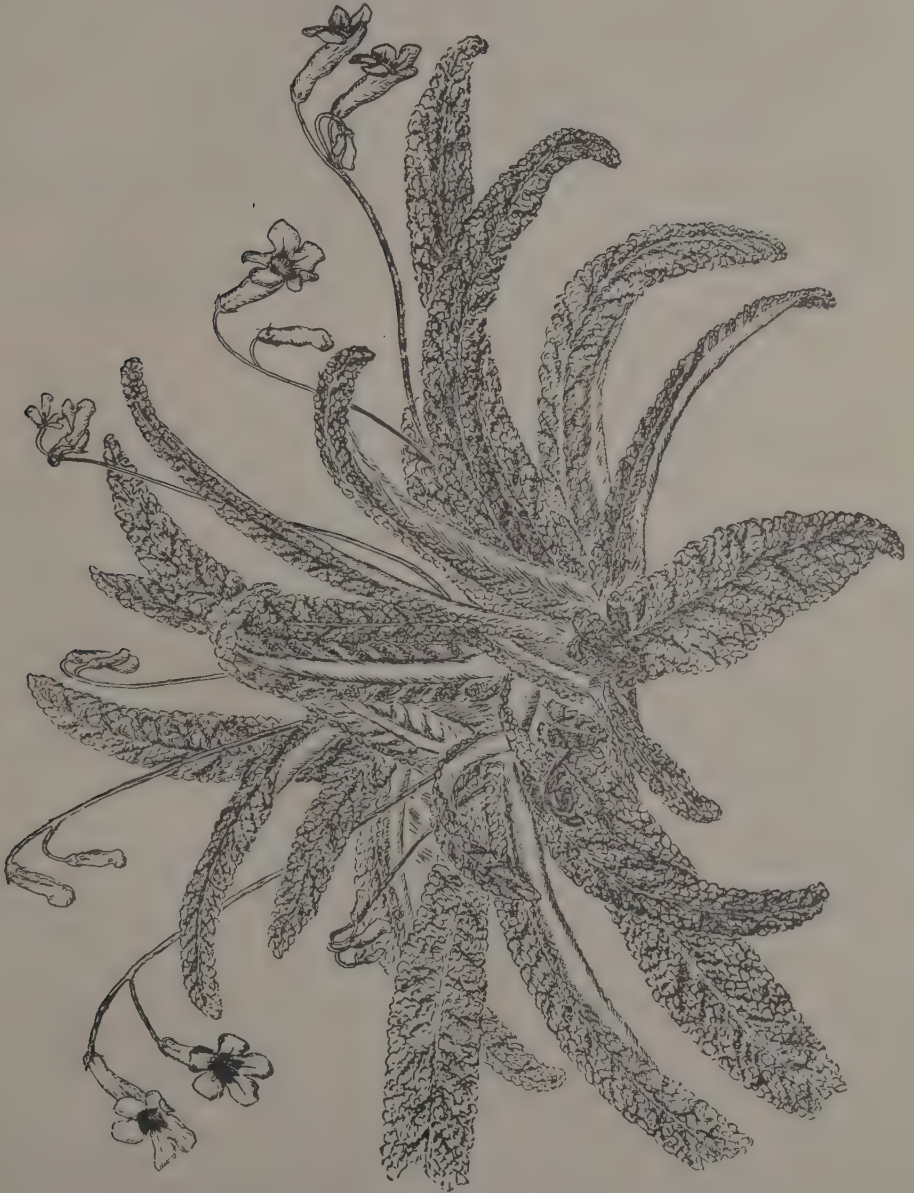


FIG. 7.—*Streptocarpus kentaniensis*,  $\times 0.6$ .

In a search by the writer for wild specimens of this species, six localities in the Kentani district were visited without success at various times between January and June, 1952. In August, 1952 directions were obtained from Mr. Mills, of Nyutura, near Kentani, and plants were located growing on a pile of rock in a forest patch estimated to receive an annual rainfall of about 25 inches. Although there are many similar piles of rock in this and other forest patches, and although another species of *Streptocarpus* is common in most of them, no *S. kentaniensis* was found except in this one place. The plants were of all sizes, and several were in flower in spite of the dry conditions then prevailing. Even when they are not flowering they may be readily recognised from the shape of their leaves.

The plants have many leaves developing in orderly succession and forming a rosette. There has so far been no sign of root runners, but occasionally a new rosette may develop adventitiously on the petiole. The flowers appear to need a specific pollinating agent, for few capsules are set naturally in cultivation. The species is unusual in flowering in winter or early summer.

The plant was recognised as an undescribed species by Miss L. L. Britten, who studied it in cultivation for many years, and who died before her work upon it was ready for publication. Her comprehensive notes were used in conjunction with the type specimen in drawing up this account.

#### IRIDACEAE.

*Moraea culmea* Killick, sp. nov., affinis *M. tenui* Ker., sed ungue lamina perianthii segmentorum exteriorum aequilongo differt.

*Cormus* 1-2 cm. diam. *Caulis* 30-55 cm. longus. *Folia* 2, caulina, inferiora linearia 9-20 cm. longa, superiora spathis similia 5.5-7.5 cm. longa. *Spathae* lanceolatae, acuminatae, cuspidatae, apicibus scarioso-fuscae, exteriores 3.2-5 cm. longae, interiores 4.2-6 cm. longae. *Perianthii* segmenta exteriora oblongo-unguiculata; lamina 7-11 mm. longa, 3-5 mm. lata, reflexa, albo-lutea; unguis cuneatus, 8-10 mm. longus, interior pubescens, nectario operculato ut basin. *Segmenta* interiora trifida, ungue 1.2 cm. longo cuspidate media lineari 4-7 mm. longa et lobis duobus falcatis lateralibus 1-2 mm. longis. *Filamenta* connata, 6-8 mm. longa; antherae 4 mm. longae. *Styli* rami 6-9 mm. longi, cristis lanceolato-acuminatis incurvatis 3-4 mm. longis; stigma integra et truncata vel 2-lobata. *Ovarium* clavatum, 7-9 mm. longum.

NATAL.—Bergville District: Cathedral Peak Forest Influences Research Station, Killick 1209; 1588 (type); Estcourt District: near Tabamhlope Police Station, Acocks 10781.

*Corm* globose, 1-2 cm. diameter; tunics with brown parallel fibres and short transverse strands. *Stem* 30-55 cm. long, slender, 1-2 mm. thick. *Leaves* 2, cauline; lower linear, sheathing at base, 9-20 cm. long, 2-4 mm. broad; upper spathe-like, completely sheathing, 5.5-7.5 cm. long, 2.5-4 mm. broad. *Spathes* cylindrical, 1-3-flowered; valves herbaceous, lanceolate, acuminate, cuspidate, scarious-brown at the tips, outer 3.2-5 cm. long, inner 4.2-6 cm. long. *Outer perianth segments* oblong-unguiculate; lamina 7-11 mm. long, 3-5 mm. broad, reflexed, outside white tinged with yellow and green-dotted, inside white with yellow puberulous blotch at base surrounded by few large green dots; claw cuneate, 8-10 mm. long, 4 mm. broad, tapering to 1 mm. at base, outside greenish-white, inside light green, pubescent, with an operculate nectary at the base. *Inner perianth segments* trifid, with a claw 1.2 cm. long and a central linear cusp 4-7 mm. long and two diverging falcate lateral lobes 1-2 mm. long. *Filaments* connate, except for upper fifth, 6-8 mm. long; anthers 4 mm. long. *Style branches* 6-9 mm. long, deeply bifid; crests lanceolate-acuminate, incurved, 3-4 mm. long. *Stigma* entire and truncate or 2-lobed with minute deltoid lobes. *Ovary* clavate, 7-9 mm. long.





FIG. 8.—*Moraea culmea*: a, flower,  $\times 3$ ; b, longitudinal section of outer perianth segment,  $\times 4$ ; c, staminal column and style,  $\times 4$ .

Our only records of *M. culmea* are from the lower slopes of the Drakensberg in the Cathedral Peak Area and Tabamhlope in the Estcourt District. In the former locality it grows socially in moist situations in *Themeda triandra* grassveld, while at Tabamhlope it is frequent—generally in Highland Sourveld. It flowers during the months of November and December. The details of flower colour given in the description above were observed in the field. On drying the flowers become yellow. The plant has a straw-like appearance, hence the specific epithet *culmea*.

*M. culmea* is closely related to *M. tenuis* Ker., but differs principally in that the claw of the outer perianth segments is equal in length to the lamina instead of half as long. In addition, it differs in flower colour and vegetatively, in not having a subradical produced leaf.

*Moraea modesta* Killick, sp. nov., affinis *M. tripetalae* Ker., sed perianthii segmenta interiora trifida non linearia differt.

*Cormus* globosus, 1–1.5 cm., diam. *Caulis* 10–25 cm. altus. *Folia* basalia 2, filiformia, 30–55 cm. et 7 cm. longa; folia caulina 2, spathis similia, 3–5 cm. longa. *Spathae* lanceolatae, apicibus scarioso-fuscae, exteriores 2–3.5 cm. longae, interiores 3–5.5 cm. longae. *Segmenta exteriora perianthii* ovato-unguiculata; lamina 8–11 mm. longa, 7 mm. lata, alba, purpurato-venata; unguis sub-erectus, 1–1.2 cm. longus, 1.5 mm. latus. *Segmenta interiora perianthii* trifida, 1.5–2.5 mm. longa, 0.5–0.7 mm. lata, purpurata, lobo medio 0.8 mm. longo et lobis duobus lateralibus minutis. *Stamina* filamentis liberis; antherae 4–7 mm. longae, apiculatae. *Styli* rami 1.4 cm. longi, cristis lanceolato-acuminatis 4 mm. longis; stigma integra, minuta. *Ovarium* cylindricum, 6–10 mm. longum.

NATAL.—Bergville District: Cathedral Peak Forest Influences Research Station, Killick 1028 (type), 1551A; below the Sentinel, Mont-aux-Sources, Galpin 10372; Little Berg, Royal National Park, West 1269.

*Corm* globose, 1–1.5 cm. diameter; outer tunics with brown parallel fibres and short transverse strands; inner tunics with thicker anastomosing fibres. *Stem* 10–25 cm. high, slender, 1 mm. thick. *Produced leaves* 2, basal, filiform, revolute, 1 mm. broad; the longer 30–55 cm. long, somewhat falcate, the other 7 cm. long, erect; cauline leaves 2, spathe-like, 3–5 cm. long. *Spathes* cylindrical, 1–3-flowered; valves herbaceous, lanceolate, scarious-brown at the tips, occasionally shortly cuspidate, the outer 2–3.5 cm. long, the inner 3–5.5 cm. long. *Outer perianth segments* ovate-unguiculate; lamina spreading, 8–11 mm. long, 7 mm. broad, white, purple-veined, with a yellow blotch at the base decurrent on the claw; claw sub-erect, 1–1.2 cm. long, 1.5 mm. broad, widening slightly just below half-way. *Inner perianth segments* trifid, minute, 1.5–2.5 mm. long, 0.5–0.7 mm. broad, with a central cusp 0.8 mm. long and two very short lateral lobes, purple. *Filaments* free, 4 mm. long; anthers 4–6 mm. long, apiculate, *Style* branches 1.4 cm. long, bifid, with lanceolate-acuminate crests 4 mm. long; stigma entire, minute. *Ovary* cylindrical, 6–10 mm. long.

This new species of *Moraea* grows on grassy slopes of the Drakensberg between 6 and 9,000 feet. The plant is rare in the Cathedral Peak Area, but common further north in the Royal National Park at Mont-aux-Sources. It flowers from October to December. As its name implies, it has a modest and rather inconspicuous appearance.

*M. modesta* is closely allied to *M. tripetala* Ker., but can be readily distinguished by having trifid instead of linear inner perianth segments. Miss G. J. Lewis of the S.A. Museum, Cape Town, who kindly confirmed that this is an undescribed species, points out that it also differs from *M. tripetala* in that the claw of the outer perianth segments is glabrous instead of minutely bearded.

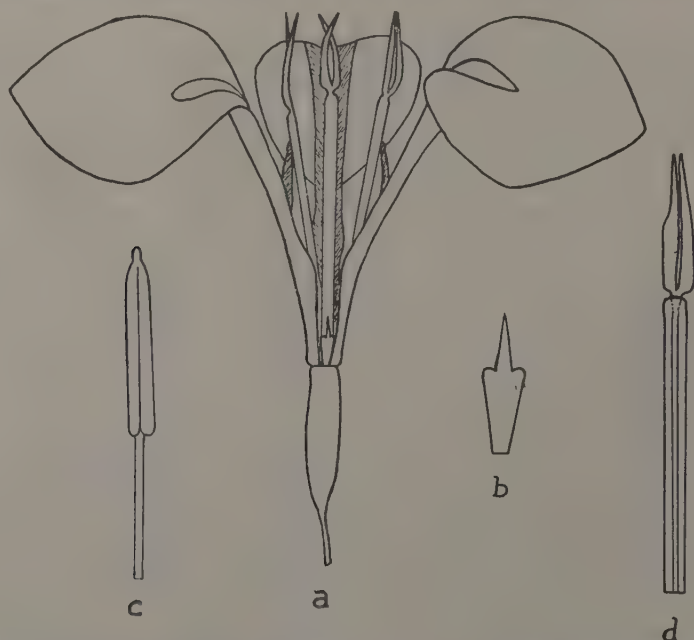


FIG. 9.—*Moraea modesta*: a, flower,  $\times 3$ ; b, inner perianth segment,  $\times 10$ ; c, stamen,  $\times 4$ ; d, style branch,  $\times 4$ .

## LABIATAE.

**Micromeria grandiflora** Killick, sp. nov., affinis *M. pilosae* Benth., sed caulibus decumbentibus, internodiis brevioribus, floribus bracteisque multo majoribus differt.

*Herba* perennis, aromatica, 15–30 cm. alta, basi parce ramosa, pilosa, glanduloso-punctata. *Caules* decumbentes. *Folia* subsessilia, ovato-cordata, 1.2–2.5 cm. longa, 1–2.2 cm. lata, serrata. *Flores* in axillis foliorum solitarii. *Pedicelli* 1–2.2 cm. longi, bibracteati. *Bracteae* foliis similes, 7–11 mm. longae, 6–10 mm. latae. *Calyx* 7–8 mm. longus; tubus subcampanulatus, 4–5 mm. longus, 15-nervus; calycis dentes 5, subaequales, triangulo-lanceolati, 4–5 mm. longi. *Corolla* pallide ad saturate cobalto-violaceum; tubus 1.3–1.7 cm. longus, parte inferiore subcylindrica 4 mm. longa 2 mm. lata, parte superiore campanulata compressa 7–9 mm. lata ostio, latere antico 2-sulcato, intus pilis longis crassis maxime duarum lilarum; labium posticum emarginatum, 2.5 mm. longum, 7–10 mm. latum; labium anticum trilobatum, lobis lateralibus emarginatis vel integris, 4 mm. longis, 5–6 mm. latis, lobo medio emarginato, 4.5 mm. longo, 6 mm. lato. *Stamina* 4, inclusa; stamina postica 3 mm. longa; antica 7 mm. longa; antherae biloculares, parallelae, cum 6–14 glandulis globosis flavis ventralibus inter cellas. *Discus* leviter lobatus. *Stylus* inclusus, 1.0–1.3 cm. longus; stigma bilobata. *Nucellae* oblongae, 3.5 mm. longae, 2.5 mm. latae.

NATAL.—Bergville District: Cathedral Peak Forest Influences Research Station, Codd and Dyer 6241, Killick 1102, 1600, 1684 (type).

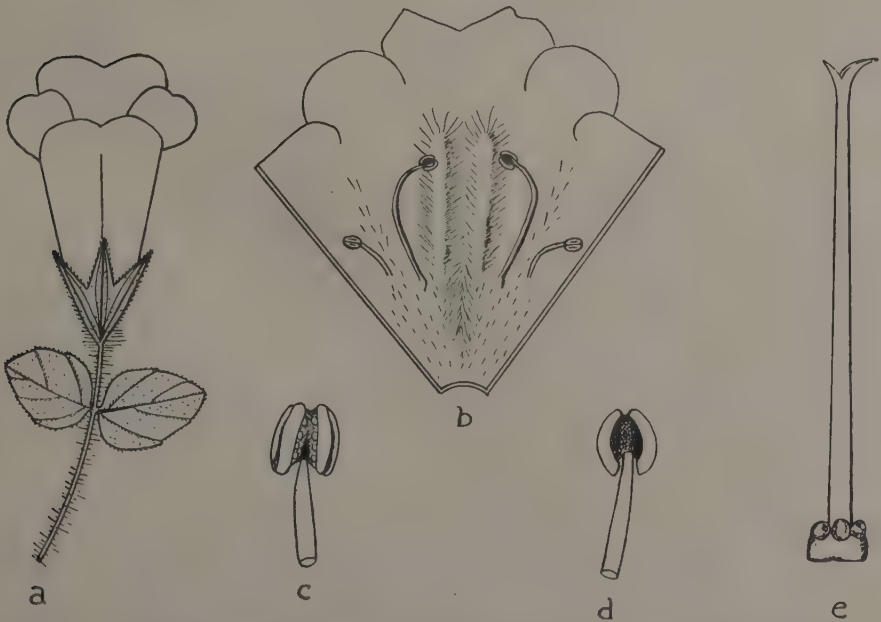


FIG. 10.—*Micromeria grandiflora*: a, flower,  $\times 2$ ; b, corolla slit down upper side,  $\times 3$ ; c, ventral side of anther with the cells slightly parted to show glands,  $\times 10$ ; d, dorsal side of anther,  $\times 10$ ; e, pistil,  $\times 5$ .



A perennial, aromatic herb, 15–30 cm. high, sparingly branched from the base, pilose with unicellular glandular hairs and multicellular eglandular hairs, golden gland-dotted. *Stems* decumbent, often with small branchlets in the axils of the lower leaves, pilose. *Leaves* subsessile, occasionally with petioles 3 mm. long, ovate-cordate, 1.2–2.5 cm. long, 1–2.2 cm. broad, serrate, teeth few, golden gland-dotted, pilose. *Flowers* solitary, axillary. *Pedicels* 1–2.2 cm. long, bibracteate about the middle, pilose. *Bracts* resembling the leaves, 7–11 mm. long, 6–10 mm. broad. *Calyx* in flower 7–8 mm. long; tube subcampanulate, 4–5 mm. long, 15-nerved, golden gland-dotted, pilose outside, glabrous inside; calyx teeth 5, sub-equal, triangular-lanceolate, 4–5 mm. long, pilose outside, glabrous inside except near the apex; calyx in fruit 9–10 mm. long. *Corolla* pale to deep cobalt-violet, 2–2.4 cm. long; tube 1.3–1.7 cm. long, subcylindric for basal 4 mm., flattened-campanulate above, 7–9 mm. wide at mouth, 2 mm. wide at base, 2-furrowed on lower side (showing as ridges inside tube), pubescent and gland-dotted outside, with long thick brown hairs inside chiefly on the two ridges; upper lip emarginate, slightly reflexed, 2.5 mm. long, 7–10 mm. broad, pilose and gland-dotted outside, glabrous inside; lower lip 3-lobed, lateral lobes emarginate or entire, 4 mm. long, 5–6 mm. broad, sparingly pilose and golden gland-dotted outside, glabrous inside, median lobe emarginate, 4.5 mm. long, 6 mm. broad, glabrous outside and inside. *Stamens* 4, didynamous, included, arcuate; posticous pair 3 mm. long; anticus 7 mm. long, shortly decurrent; filaments glabrous; anthers 2-celled, parallel, 1 mm. long, with 6–14 round yellow glands situated ventrally on the connective between the cells. *Disc* slightly lobed. *Style* included, 1–1.3 cm. long; stigma bilobed, lobes acute, the posticous the shorter. *Nutlets* oblong, 3.5 mm. long, 2.5 mm. broad, brown, shortly hairy.

The first gathering of this new species of *Micromeria* was made by the author in November, 1950. It was subsequently collected by Drs. L. E. Codd and R. A. Dyer in December of the same year and again by the author in November, 1951 and February, 1952. The plant forms small societies in undisturbed *Themeda triandra* grassveld at about 6,400 feet on the Little Berg in the Cathedral Peak Area. All the specimens cited were collected from the same spot. This species appears to be very localized. The author has spent over a year in the Drakensberg doing botanical survey work, but has seen it growing in only two small catchment areas.

*M. grandiflora* is a summer flowering perennial producing flowers from the beginning of November until the middle of March. The plant is strongly aromatic producing a mentha-like smell when bruised. Responsible for this are the numerous gland-tipped hairs and sunken golden glands covering most parts of the plant.

Besides *M. grandiflora*, there are two other species of *Micromeria* in South Africa, *M. biflora* Benth. and *M. pilosa* Benth., the former occurring in the Eastern Cape, Transvaal and Basutoland, while the latter is found in Natal and Pondoland. *M. grandiflora* has affinities with *M. pilosa*, but differs in that the stems are decumbent instead of prostrate, the internodes are shorter and the flowers and bracts are very much larger. *M. pilosa* also grows in the Cathedral Peak Area, but as a rule occupies moister situations than *M. grandiflora*.

## LILIACEAE.

*Aloe babatiensis* Christian and Verdoorn sp. nov. in *Procrassae* Berger ab *A. percrassae* inter alia plantis caulescentibus foliis brevioribus, ab *A. rubroluteae* plantis minoribus perianthiis formis facilliter distinguitur.

*Truncus* simplex, circa 50 cm. altus, apicem versus dense foliatus infra foliis exsiccatis deflexis obtectus. *Folia* rosulata, patentia, apicem versus recurvata, ovato-lanceolata vel lanceolata, acuta, plus minusve 27 cm. longa, 6 cm. lata, supra saligneae nitidula, obscure lineata, immaculata vel interdum basi maculis albidis paucis

nstructa, subtus pallido-viridula, convexa, obscure lineata, immaculata; margines acuti, sinuato-dentati; dentes deltoidei, 4 mm. longi, 5–12 mm. distantes apicibus rubro-bruneis pungentibus. *Inflorescentia* erecta 40–80 cm. longa, infra medium ramosa; pedunculus viridis, apicem versus bruneolus, compressus, 25 mm. latus, basin versus anguste hyalino-marginatus, marginibus minute dentatis; bracteae subamplexicaulis, 8-nervatae, 35 mm. longae, basi 35–40 mm. latae, sensim acuminatae, apicem versus abrupte apice obliquo-acuminatae; rami 3, erecti bracteis vacuis paucis vestiti. *Racemi* cylindraco-acuminati, subdensi terminales usque 30 cm. longi; bracteae pallido-virides 7–8-nervatae, 27 mm. longae, basi 2–15 mm. latae, oblongo-ovatae; pedicelli pallido-virides vel flavo-virides, erecti deinde cernui, 18–25 mm. longi. *Perigonium* armeniacum vel salmonium, ca 3·7 cm. longum, cylindraco-subtrigonum leviter decurvum, basi rotundatum vel truncatum circa ovarium 5–6 mm. diam. supra ovarium leviter constrictum 4·5–5 mm. diam. deinde apicem versus ampliatum, segmentis rectis vel sub-patentibus; segmenta exteriora per 12 mm. libera obtusa; segmenta interiora ad margines libera, dorsifixi. *Antherae* croceae sub-exsertae. *Ovarium* viridulum, 6–8 mm. longum, 2–3 mm. latum apicem versus leviter acuminatum; stylus citrinus, deinde exsertus.

TANGANYIKA TERRITORY.—About 50 m. N.W. of Babati on road to Ngorongoro Crater, *Pole Evans & Erens* 872 in Herb. Christian 985 and in N.H. No. 28489, flowered at Ewanrigg 16/9/46 (type), leaves from same plant collected 13/7/50.

#### PLATE 6.

*Stem* simple about 50 cm. high foliate with a crown or rosette of leaves on the apical portion and old dry leaves below. *Leaves* crowded above with only some of the lower leaves of the rosette sometimes showing a short clasping base, spreading, decurved towards apex, ovate-lanceolate to lanceolate, acute, about 27 cm. long and 6 cm. wide, upper surface dark shining green, shading to copper colour in the dry season where exposed to sun, shallowly and broadly concave, sometimes obscurely lineate, immaculate or sometimes with one to few white spots near the base; lower surface pale green, lineate, immaculate, convex, margins acute, sinuate dentate; teeth deltoid spreading with reddish-brown pungent tips 4 mm. long, 8–12 mm. apart, closer lower down. *Inflorescence* erect, 40–80 cm. long, branched from below the middle, branches 3 (in specimens seen) erect or arcuate, crowding together; peduncle green shading to fawn above, laterally compressed low down; about 25 mm. broad, flat on one surface, rounded on the other, edges acute and, in lower half, with a very narrow hyaline margin which is very minutely toothed; bracts at base of branches sub-amplexicaul, about 8-nerved, 35 mm. long and 35–40 mm. broad at the base gradually narrowing towards apex where they narrow abruptly to an oblique acute apex, sterile bracts below the racemes somewhat smaller. *Racemes* up to 30 cm. long, cylindric-acuminate, sub-dense; floral bracts pale green, 7–8-nerved, 27 mm. long, base 12–15 mm. broad oblong ovate; pedicels pale green or yellowish-green, erect, those of mature flowers cernuous, 18–25 mm. long. *Perianth* apricot-orange to salmon-pink (buds green-tipped; lobes of open flowers yellowish), about 3·7 cm. long cylindric-subtrigonal, slightly decurved, rounded or sub-truncate at the base, about 5–6 mm. diam. over the ovary, slightly constricted above the ovary to 4·5–5 mm. diam. and widened above to 9 mm. and then contracted at the mouth with the lobes eventually sub-spreading; outer segments free for 12 mm., pale pink on margins with a broad deeper pink median portion, apices obtuse straight to sub-spreading; inner segments free on the margins, dorsifixi to tube, white with a broad reddish median line, obscurely nerved, apices obtuse straight to slightly spreading. *Stamens* with white filaments and terra-cotta anthers which are sub-exserted. *Ovary* green 6–8 mm. long 2–3 mm. broad, tapering slightly to the apex; style yellow to pinkish eventually exserted.

The following notes are by the second author, I. C. Verdoorn.

Plants of this *Aloe* were originally collected on the Pole Evans' Central and East African Expedition, Sept. 1938. They were not flowering at the time and for years they did not flower either in the Transvaal or in Rhodesia. Plants were distributed to different gardens in both these regions in the attempt to strike the conditions which would induce flowering. Eventually (Sept. 1946) one plant flowered at Ewanrigg, Mr. Christian's farm near Salisbury where Mr. Christian then described and photographed it. The herbarium specimen which he prepared at the time is the type. In October, 1951, one of the plants of the same collecting, which Mr. Christian had given to Mr. Munch of Rusapi to cultivate, flowered and the inflorescence was sent by air to Mr. Reynolds of Johannesburg. This material was kindly donated to the National Herbarium and afforded the opportunity of checking the late Mr. Christian's description for publication.

With regard to the relationship of this new species, unfortunately Mr. Christian did not leave any notes expressing his views. The broad bracts, which are longer than and envelop or conceal the pedicels, together with the rounded base (not stipitate) of the perianth and the general habit place it in the series *Procrassa* of Berger, *Das Pflanzenreich* 1908. It is readily distinguished from the described species in this series. In general appearance it is most like *Aloe percrassa* but differs, in the first place, by having a stem, and also in the smaller leaves and slightly longer perianths. In the large bracts it resembles the well known species, *Aloe cryptopoda*, in Berger's series *Latebracteatae* but otherwise has very little in common with this species and the others in the *Latebracteatae*.

The most striking characters about the inflorescence of *Aloe babatiensis* are the large pale green, rather thick bracts, the erect branches crowding the racemes together and the conspicuous sterile bracts below the racemes. The colour of the flowers is something between apricot-orange and salmon-pink and the buds are green-tipped. The habit is characterised by the spreading leaves which narrow perceptibly from a broad base which may be described as deltoid acuminate, and are crowded in a rosette at the top of the stem. Some of the lower leaves of the rosette show a very short amplexicaul base and below them the stem is covered with the remains of old dried leaves. The upper surface of the leaf is rather dark green and shining.

According to one of the collectors, Mr. Erens, the plants were found about 50 miles N.W. of Babati on the road to Mbulu and the Ngorongoro Crater "growing on granite outcrops in a valley with plenty of leafmould, young plants forming on the stems".

***Asparagus multituberosus* R. A. Dyer, sp. nov., affinis *A. asparagoidei* (L) Wight caulo subterraneo elongato multituberoso stylo tripartito differt.**

*Herba* perennis. *Caulis* subterraneus attenuatus usque 35 cm. longus vel longior tuberis multis densis circiter 1 cm. longis, 2 mm. latis indutus. *Rami* lateraliter producti, plus minusve ramosi, graciles, glabri, espinosi, 20–45 cm. longi, angulares. *Folia* parva, ovata, acuminata, membranacea. *Phyllocladia* sessilia, ovata vel basi cordata, 1.5–2.5 cm. longa, 1–2 cm. lata, nervis 8–10. *Flores* axilares, penduli, 1–3, pedunculis plus minusve 5 mm. longis apicem versus articulatis. *Perianthium* 7 mm. longum segmentis oblongis albis carina viride. *Filamenta* lineari-lanceolata, basi lobata. *Ovarii* loculi 12-ovulati. *Stylus* tripartitus.

CAPE PROVINCE.—Ceres Division: among shrubs on hills near Karoopoort, Aug., Marloth 9006 (type); Calvinia Division: Calvinia commonage among shrubs, Marloth 12778.

*Perennial herb* with rhizomatous rootstock. *Rhizome* elongating up to 30 cm. or more, unbranched or sparsely branched, producing along its whole length densely packed sessile tuberous roots about 1 cm. long and 2–3.5 mm. thick, and with a few long non-tuberous roots. *Stems* 1—few arising laterally from the rhizome,



subscandent, glabrous, spineless, 20–45 cm. tall, ribbed or angled. *Leaves* small, scale-like, ovate, acuminate, membranous. *Phyllocladia* sessile, ovate to broadly ovate or cordate, 1.5–2.5 cm. long, 1–2 cm. broad, slightly oblique, with 8–11 main veins. *Flowers* axillary, 1–3; pedicels slender curved, about 5 mm. long, articulated slightly below the perianth. *Perianth* 7 mm. long with the segments united at the base; segments linear-oblong, obtuse, 2.5 mm. broad. *Stamens* with filaments attached 1–1.5 mm. above the base of the perianth segments; filaments lanceolate, eared at the base; anthers oblong, 1.5 mm. long. *Ovary* oblong, 2–2.5 mm. long, 12 ovules in each cell. *Styles* 3, free, about as long as the ovary; stigmas truncate, minutely papillate.

The branches and leaves of this plant are very similar to those of *A. asparagoides* (L.) Wight (= *A. medeoloides* Thunb.), and *A. ovatus* Salter, but the root system is very different. The tripartite style or 3 free styles of *A. multituberosus* is apparently an unusual feature in the genus and is an important distinguishing character of this species. A duplicate specimen in the National Herbarium of Schlechter 8069, from Windhoek in the Clanwilliam district, Cape Province, possibly belongs to this species. The specimen does not possess roots but the flowers have a 3-partite style.

**Eriospermum bifidum** R. A. Dyer, sp. nov., folio erecto racemo denso segmentis aequalibus filamentis bifidis distinguitur.

*Tuber* 4–9 cm. longum, 4–5 cm. crassum, simplex, rariter ramosum. *Folium* solitarium; lamina erecta, oblongo-lanceolata, 7–12 cm. longa, 2–3 cm. lata, concava, subglauca; petiolus erectus, 5–10 cm. longus, gracilis. *Pedunculus* gracilis, 20–25 cm. longus, erectus, basi bractea parva subtentus. *Racemus* 3–5 cm. longus, 20–30-florus, densus, pedicellis erectopatentibus 5–15 mm. longis. *Perianthemum* regulare, 4–5 mm. longum; segmenta basi breviter connata, obovata, 3–4 mm. longa, supra medium 2–2.5 mm. lata, obtusa. *Filamenta* oblongo-elliptica, 2–2.5 mm. longa, leviter crassa, apice bifida, antheris oblongis, 1 mm. longis. *Ovarium* 1–1.5 mm. longum, obtuse 3-angulatum. *Stylus* cylindricus; stigma subcapitata.

CAPE PROVINCE.—Bathurst Division; near Clumber, on dry hillside near scrub bush, Dyer 383a (GRA); Albany Division: Committees in arid scrub, Dyer 513 (GRA); 8–10 miles from Grahamstown at Bothas Hill, in arid scrub, Dyer 670 (PRE); 1299 (GRA) type; 35 miles from Grahamstown on old Port Elizabeth Road in scrub, Dyer 1084; 22–24 miles from Grahamstown towards Carlisle Bridge, arid flats, Dyer 2113 (GRA).

*Tuber* sausage-shaped or somewhat pyriform, simple or occasionally branched, 4–9 cm. long, 4–5 cm. thick, shrivelling in very dry weather, about 10 cm. deep in soil and with old persistent fibrous petiole-like leaf bases. *Leaves* tough; lamina erect, oblong-lanceolate, glabrous, 7–12 cm. long, 2–3 cm. broad, concave on upper surface, somewhat glaucous; petiole wiry, 5–10 cm. long. *Peduncle* subtended by small sheathing bract, 20–25 cm. tall, erect. *Raceme* 3–5 cm. long, dense, 20–30-flowered; pedicels 5–15 mm. long, spreading-erect; bracteoles minute. *Perianth* 4–5 mm. long, regular; segments shortly united at the base, greenish-yellow with darker green stripes down back, all equal, obovate, 3–4 mm. long, 2–2.5 mm. broad. *Filaments* greenish-yellow, elliptic-oblong, 2 mm. long, bifid at the apex; anthers versatile 1 mm. long, attached at the sinus of the filament lobes. *Ovary* 1–1.5 mm. long, slightly 3-angled. *Style* about equal to ovary in length; stigma somewhat capitate.

When flowers of this species were first examined in 1927, doubt arose whether it could be included in the genus *Eriospermum* at all on account of the bifid filaments.

The late Dr. R. Marloth, a specialist on the genus at the time, reported as follows: "It is different from all others that I have seen, but some I have possess spatulate stamens with the anthers attached to a small mucro at the apex facing introrsely. There seem to be all kinds of transitional stages from the linear to the ovate, oblong, spatulate forms on to yours with an emarginate obovate filament." A. V. Duthie also makes reference to the specimens in her "Contribution to our Knowledge of the Genus *Eriospermum*" in Ann. Univ. Stellenbosch, 1940, p. 11. The filaments are more than emarginate at the apex and cannot strictly be described as obovate.

Most workers interested in the genus *Eriospermum* have pointed out the many difficulties which face one in trying to classify herbarium material. The main difficulties arise because so many species produce leaves and flowers at different times of the year, and incomplete specimens in herbaria are the rule rather than the exception.

***Eriospermum zeyheri* R. A. Dyer sp. nov.**, folio prostrato racemo leviter denso perianthi segmentis aequalibus distinguitur.

*Tuber* subpyriforme usque 3 cm. crassum. *Folium* solitarium; lamina leviter carnosae, glabra, cordata vel lobis plus minusve imbricata, 5-9 cm. longa et lata, rotundata vel apiculata. *Pedunculus* erectus, 20-30 cm. longus basi bractea parva subtentus. *Racemus* densus, 8-12 cm. longus, 20-40-florus, pedicellis erecto-patentibus 5 mm. vel non-numquam usque 1 cm. longis. *Perianthium* subcampanulatum, 4-5 mm. longum; segmenta basi breviter connata, oblanceolato-oblonga, supra medium 2-2.5 mm. lata, obtusa. *Filamenta* oblongo-elliptica, 2-2.5 mm. longa, 1.25-1.5 mm. lata, antheris oblongis 1 mm. longis. *Ovarium* 1-2 mm. longum, loculis 3-ovulatis; stylus cylindricus 1 mm. longus.

CAPE PROVINCE.—Albany Division: 6 miles from Grahamstown along road to Cradock, Sept. (leaves) and flowers added later, *Dyer* 557 (type in Herb. Alb. Mus.); Port Elizabeth Division: on hills near Port Elizabeth, March (flowers) *Zeyher* 4281.

*Tuber* simple, inverted, subpyriform, with a groove on one side along which the persistent petiole-like leaf bases pass, 3 cm. broad towards the growing end and narrowing to the old base which is uppermost in the ground, with a fairly tough skin, 5-7 cm. below ground. *Leaves* with soft lamina which is somewhat fleshy, glabrous, adpressed to ground, usually light green and glossy, deeply cordate or with basal lobes overlapping, about as broad as long, 5-9 cm. wide, obtuse or apiculate. *Peduncle* with short sheathing bract, 20-30 cm. tall, usually stiffly erect. *Raceme* 8-12 cm. long, dense 20-40-flowered; pedicels about 5 mm. long, spreading-erect; bracteoles minute. *Perianth* usually yellowish-green with a darker central stripe on the segments, regularly campanulate in outline; segments almost free to base, spreading with age, oblanceolate-oblong, obtuse, the outer very slightly shorter and narrower than the inner, 4-5 mm. long, 2-2.5 mm. broad. *Filaments* elliptic-oblong, 2-2.5 mm. long, 1.25-1.5 mm. broad; anthers oblong, 1 mm. long. *Ovary* 1-2 mm. long, 3-6 ovules in each ovary cell. *Style* cylindric, 1 mm. long.

The leaves of this species appear in spring and die back in summer while the inflorescences develop about March and soon mature. It is not known whether Baker had a complete specimen for study when he prepared the account of the genus for *Flora Capensis* Vol. 6 (1896). A specimen of *E. zeyheri* Zeyher 4281 in the National Herbarium consists of an inflorescence only and the number is cited by Baker under the species *E. bellendini*. It is certainly not conspecific with the typical plant figured in Curtis's Botanical Magazine, t. 1382 and it appears evident that Baker used the latter name as a dumping ground.

The present species is characterised by the glabrous glossy, light-green leaves pressed to the ground and the rather short dense and stiffly erect racemes of more or less regular yellowish flowers. So far it appears that the distribution is restricted to the eastern Cape, from Uitenhage and Port Elizabeth to Albany Division.

#### PHYTOLACCACEAE.

***Psammotropha alternifolia* Killick, sp. nov., affinis *P. androsaceae* Fenzl., sed habitu minore compactiore, pedunculis pauco-nodosis, foliis alternatis differt.**

*Herba* procumbens, 2.5–6.2 cm. alta, multo-ramosa. *Folia* alterna, ramorum apicibus conferta, elliptico-oblonga, 2–3.5 mm. longa, 1–1.2 mm. lata, albomarginata, breviter mucronulata. *Pedunculi* solitarii, 0.4–1.9 cm. longi, verticillo bractearum terminale et subterminale. *Flores* umbellulati, minuti, cremeoflavi. *Pedicelli* 1 mm. longi, basi bracteolati. *Sepala* oblonga, cucullata, 1.5–2 mm. longa, 1.3 mm. lata. *Stamina* 1.5 mm. longa. *Ovarium* 3-angulatum, disco hypogyno; stylus 1 mm. longus, 3-fidus.

**NATAL.**—Bergville District: Mont-aux-Sources, Mann 2865 b, Potts 2971, Hutchinson, Forbes and Verdoorn 108; Beacon Butress, Galpin 10369; near Cleft Peak, Schelpe 475; near Castle Butress, Killick 1482 (type); Organ Pipes Pass, Killick 1842.

Procumbent herb, 2.5–6.2 cm. high, much branched. *Leaves* scattered alternately on the branches and tufted at the apices, elliptic-oblong, 2–3.5 mm. long, 1–1.2 mm. broad, white-margined, shortly mucronulate. *Peduncles* solitary, 0.4–1.9 cm. long, with a terminal and subterminal whorl of bracts each whorl supporting an umbellule. *Flowers* minute, cream-yellow. *Pedicels* 1 mm. long, bracteolate at base. *Sepals*

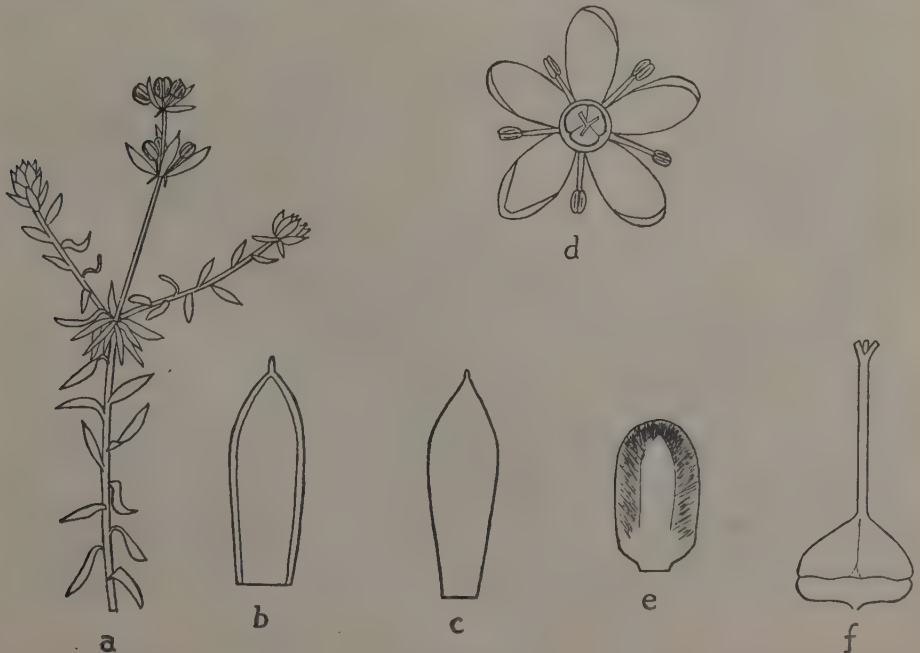


FIG. 11.—*Psammotropha alternifolia*: a, portion of flowering branch,  $\times 3$ ; b, leaf,  $\times 10$ ; c, bract,  $\times 10$ ; d, flower from above,  $\times 10$ ; e, sepal, dorsal view,  $\times 10$ ; f, pistil and disc,  $\times 20$ .



oblong, cucullate, 1.5-2 mm. long, 1.3 mm. wide. *Stamens* 1.5 mm. long. *Ovary* 3-angled, situated on a saucer-shaped disc; style 1 mm. long, 3-fid.

The known range of this species on the Drakensberg is between the Organ Pipes Pass in the Cleft Peak Area and Mont-aux-Sources further north.

*P. alternifolia* is essentially a rock-crevice plant, but occasionally it grows in mud patches present in alpine grassveld. Like many other plants of high altitudes it has a tufted, dwarfed habit. It flowers from November to late April. In spite of its small size, it is quite conspicuous when in flower; the profusion of cream-yellow flowers makes the plant stand out strikingly against the brown of the adjacent basalt.

This species is nearest *P. androsacea* Fenzl., but can be easily distinguished by its dwarfed, compact habit, by the 2-noded peduncles and by the presence of leaves scattered alternately on the branches. It derives its name from this latter character. It also differs in that the leaves are less conspicuously mucronate.



PLATE 1.—*Tavaresia meintjesii* R. A. Dyer. [Photos B. Meintjes.]



PLATE 2.—*Encephalartos eximius* Verdoorn, habitat on hills between Bedford and Tarkastad [Photo R. A. Dyer.



PLATE 3.—*Encephalartos eximius* Verdoorn, on hill between Bedford and Tarkastad. [Photo R. A. Dyer.



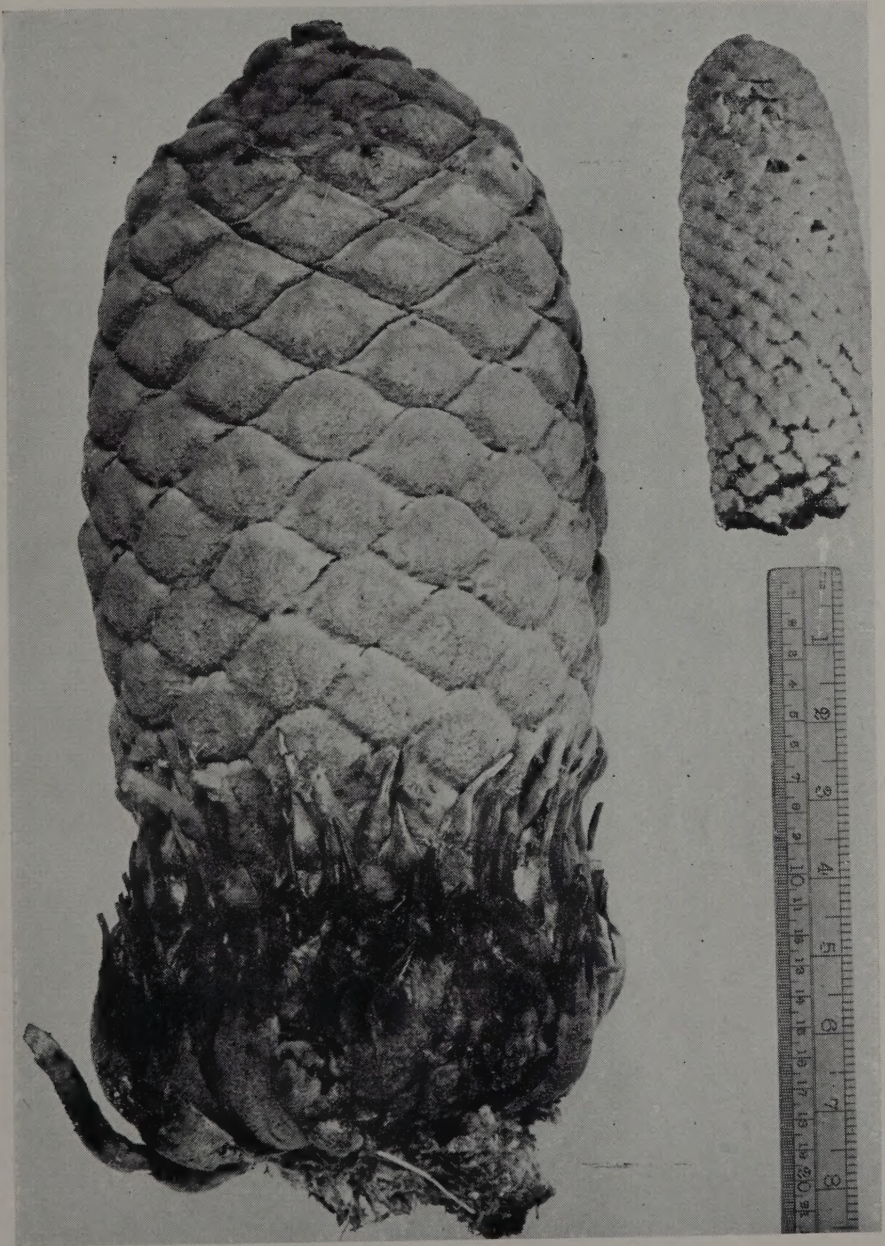


PLATE 4.—*Encephalartos eximius* Verdoorn, female cone on left, Story 4021; male cone on right, Story 4019; from plants on hills between Bedford and Tarkastad.  
[Photo H. King.]



PLATE 5.—*Pelargonium jacobii* R. A. Dyer.



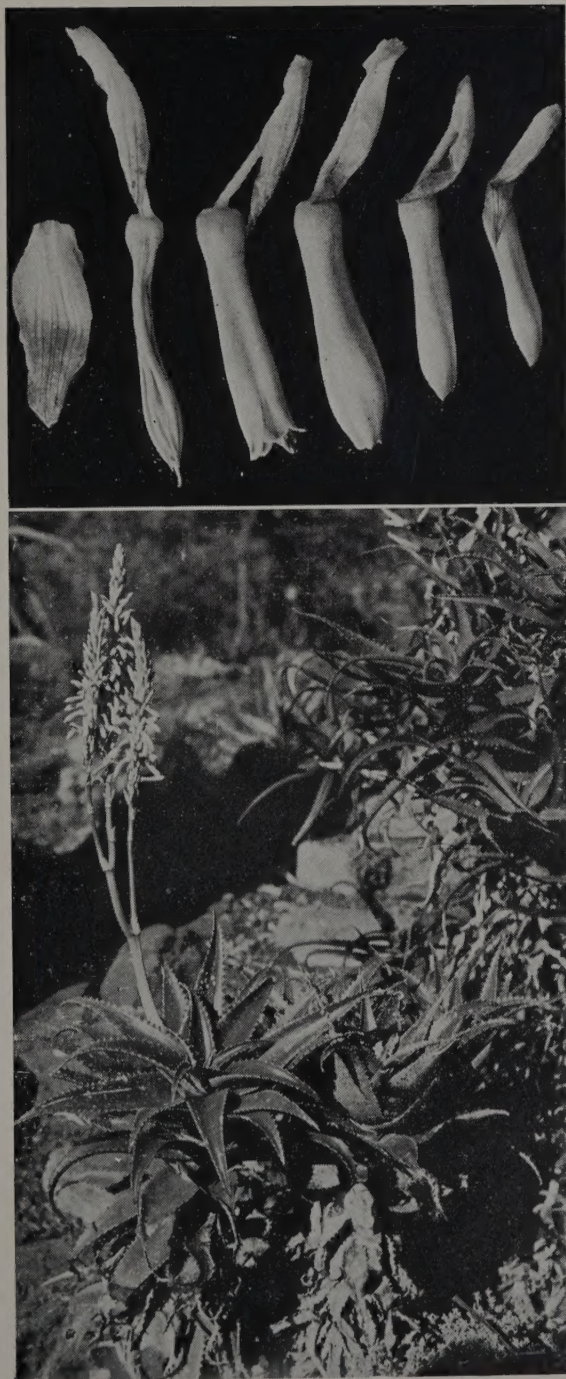


Plate 6.—*Aloe babatiensis* Christian & Verdoorn.  
[Photo G. W. Reynolds.]



